What Works to Increase Access to Assistive Technology in Southern Africa

By

Rebecca Matter

MTTREB001

Submitted to the University of Cape Town

In fulfilment of the requirements for the degree

Doctor of Philosophy in Public Health

School of Public Health and Family Medicine,

Faculty of Health Sciences

University of Cape Town

May 2020

Supervisor: Christopher J. Colvin

Faculty of Health Sciences

University of Cape Town

Declaration

This thesis is presented in fulfilment of the requirements for the degree of Doctor of Philosophy in the School of Public Health and Family Medicine, at the Faculty of Health Sciences, University of Cape Town.

I, Rebecca Matter, hereby declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

I empower the University of Cape Town to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

Signature: Signed by candidate Date: 9 May 2020

Inclusion of publications in PhD thesis

I confirm that I have been granted permission by the University of Cape Town's Doctoral Degrees Board to include the following two publications in my PhD thesis and my co-authors have agreed that I may include the publications listed below. I am lead author on these two multi-authored papers and my specific contributions to these papers are described at the end of Chapters 3 and 4.

- Rebecca Matter, Mark Harniss, Tone Oderud, Johan Borg & Arne H. Eide (2016): Assistive technology in resource-limited environments: a scoping review, Disability and Rehabilitation: Assistive Technology, 12:2, 105-114, DOI: 10.1080/17483107.2016.1188170.
- Rebecca Matter & Arne H. Eide (2018): Access to assistive technology in two Southern African countries. BMC Health Services Research. Oct 19;18(1):792, DOI: 10.1186/s12913-018-3605-9.

Signature: Signed by candidate Date: 9 May 2020

Student name: Rebecca Matter Student number: MTTREB001

CONTENTS

ACRONYMS

AAC: augmentative and alternative communication

ADL: aid for daily living

APL: Priority Assistive Product List

AT: assistive technology

ATM: access to medicines

BBBEE: Broad-Based Black Economic Empowerment

CRPD: United Nations Convention on the Rights of Persons with Disabilities

CBR: community-based rehabilitation

CHW: community health workers

DPO: disability persons organization

GATE: Global Cooperation on Assistive Health Technology

GDI: Global Disability Innovation Hub

ICT: information and communication technology

ISO: International Organization for Standardization

LCS: Living Conditions Studies

LMICs: low- and middle-income countries

MOH: Ministry of Health

MOE: Ministry of Education

MOSS: Ministry of Social Services

NGO: non-governmental organization

OT: occupational therapy

PT: physical therapy

RLEs: resource limited environments

RAF: Road Accident Fund

SADC: Southern African Development Community

SAFOD: Southern African Federation of the Disabled

SDGs: Sustainable Development Goals

SLP: speech language pathologist

UNICEF: United Nations International Children's Emergency Fund

USAID: U.S. Agency for International Development

WCF: Works Compensation Fund

WHO: World Health Organization

LIST OF TABLES

LIST OF FIGURES

LIST OF CHARTS

LIST OF BOXES

ABSTRACT

Access to assistive technologies (AT) is necessary to achieving all 17 sustainable development goals. Yet for most people who need AT in Southern Africa, AT is unaffordable, unavailable and often inappropriate.

My PhD research was guided by the core question: What works to increase access to assistive technology in Southern Africa? Organized into three sub-studies, my research aimed to identify and describe the facilitators and barriers to access AT and develop a theoretical model to inform strategies to increase AT access in Southern Africa. The first two sub-studies listed below were previously published and the full manuscripts are included as separate chapters within the thesis. The three sub-studies included:

- Sub-study 1: A scoping review that characterized existing evidence on AT from resource limited environments. Evidence identified was limited in quantity and quality, and primarily focused on mobility and vision types of AT.
- Sub-study 2: A secondary analysis (i.e., bivariate regressions) of national survey data from Botswana and Swaziland served to examine factors associated with higher levels of AT access. The type of disability (i.e., mobility vs. non-mobility) was found to be the most important factor in determining AT access in both countries.
- Sub-study 3: A regional qualitative sub-study was conducted to increase the understanding of how a multitude of interrelated factors operate to increase the supply of and access to AT. An adapted health systems framework was applied to analyse multiple data sources including stakeholder interviews, documentation review and observations.

The thesis is organized into seven chapters. In **Chapter 1**, I provide background information and conceptual framing of the research topic, assistive technology access within Southern Africa. The research questions and overview of the three sub-studies are included in this introductory chapter. **Chapter 2** covers the research methods of all three sub-studies. For the first two sub-studies, a brief overview of data collection and analysis methods are included that reference the more detailed methods presented within each published manuscript.

The first two sub-studies are presented as **Chapter 3** (scoping review) and **Chapter 4** (secondary analysis) within the thesis. The third sub-study (qualitative) provided the most comprehensive data of the three sub-studies and comprises findings presented in **Chapter 5** and **Chapter 6**.

In the final chapter, **Chapter 7**, I synthesize findings from all three sub-studies to identify prominent patterns and present models that aim to explain constraints within the AT sector. The synthesis of

evidence showed that AT in Southern Africa does not operate as a sector but as a constellation of uncoordinated parts. The low prioritization of AT and high level of fragmentation within the system emerged as pervasive patterns. The combination of these two patterns result in a wasteful sector. This means that the limited resources invested in funding products and services, and in strengthening the national AT procurement and provision system are not used effectively to increase the supply of and access to appropriate AT.

In my further interpretation of data to respond to the core research question: What works to increase access to assistive technology in Southern Africa? I then identify strategic levers to increase AT access. Strategic levers aim to increase resources invested in the AT sector while reducing system-wide inefficiencies. Finally, study limitations and conclusions are presented at the end of this final chapter.

MOTIVATION

Having grown up with a dad who is an above-knee amputee and depends on a prosthesis, I have been familiar with the importance of AT all my life. In the high-resourced context of the U.S., my dad has never been without a prosthesis since he lost his leg in a motorcycle accident at age 19. Now 72, he estimates that the combined cost for the 8 prosthetics legs he has received over the past 50+ years is over $150,000 USD. Technology has improved dramatically, evolving from a limb made of maple wood in 1967 to the lightweight, flexible and durable carbon steel with high-end knee and foot components he uses today. His access, product choices and sustained use have primarily depended on the level of coverage of employer-sponsored (medical aid) and government (Medicare) health insurance, as well as advocacy efforts by dedicated health professionals and the ability to cover out of pocket costs (e.g., Medicare covers 80%).

In contrast, I have come across many cases though my work and research in Southern Africa of amputees in need of a prosthetic limb who settled for a wheelchair, crutches or even hopping/crawling because a prothesis is not available, appropriate or is in disrepair. This is the situation for all types of AT across most resource limited worldwide – unavailable and inappropriate.

In 2009, I began developing an international initiative at the University of Washington (UW) with a few colleagues that focused on the rehabilitation and assistive technology (AT) needs of people within low resourced countries. There were few funding opportunities to support this work even though the magnitude of unmet needs was huge. The initiative led to a few small projects, in Brazil and Southern Africa, which honed my interest specifically on access to AT.

For me, access to AT is first and foremost about human rights and social justice, and those in need of AT are among often the most vulnerable, excluded and isolated. I initiated my doctoral research with the aim to identify approaches to increase AT access throughout Southern Africa.

ACKNOWLEDGMENTS

During my 15 year career at the University of Washington (UW), I was fortunate to have mentors that supported my exploration of disability rights within low-resourced countries. Without the leadership and encouragement of key people at the UW Centre for Technology and Disability Studies, namely Sharan Brown, Mark Harniss, Kurt Johnson and Pat Brown, I would not have embarked on this doctoral journey. Mark Harniss was also an integral partner in developing and implementing international AT projects.

Conducting the doctoral research, from drafting the first concept paper, through all stages of development, data collection, analysis and writing was guided my supervisor Christopher Colvin. Chris is an insightful supervisor who was able to reframe my work when I got stuck and provided a balanced approach to conducting research with academic rigour that was also feasible. Given the breadth of the topic, the synthesis was particularly challenging, and Chris continually helped me refocus on the core research question and aims. I also greatly appreciated the ongoing meetings during the final two years when I was conducting analysis and writing from Seattle.

My co-supervisor Arne Eide was encouraging throughout my doctoral study and provided valuable feedback that strengthened the overall thesis. Arne also provided the datasets for sub-study 2 and guided the statistical analysis approach and writing of the secondary analysis publication.

I am grateful for the time and expertise all interview participants contributed to this effort. Participants were recruited through previous professional contacts and the AT-Info-Map project. Tone Oderud and Shona McDonald opened the door to developing relationships in the AT community in Southern Africa back in 2012. George Kayange and Mussa Chiwaula from the Southern African Federation of the Disabled (SAFOD), Gubela Mji from Stellenbosch University, and Mark Harniss (UW) collaborated on the AT-Info-Map project and were a joy to work with on this innovative effort. Though the funded project ended in early 2019, SAFOD continues to serve as a regional platform for raising awareness about the needs for AT across Southern Africa.

Finally, the completion of this doctoral study, that took nearly 2 years longer than initially planned, would not have been possible without the support of my husband, Hans Kelstrup, family and friends.

CHAPTER 1 INTRODUCTION AND LITERATURE REVIEW

In this chapter I provide the rationale for pursuing this topic of study, conceptual definitions and framing applied to shape the study design, and research questions and objectives.

1.1 STATEMENT OF PROBLEM

Assistive technologies such as hearing aids, wheelchairs, prosthetics and eyeglasses include a wide range of technology products and services that serve to improve an individual's functioning and independence. For the majority of people residing in resource limited settings (commonly found in low- and middle-income countries (LMICs)), assistive technology (AT) is unaffordable, unavailable and often inappropriate (Eide and Øderud 2009, Andrysek 2010, WHO 2018a). Without access to appropriate AT, individuals who require AT experience increased barriers to participation in education, employment, health care, recreation and other activities; decreased quality of life and health status including increased comorbidities (e.g. depression and pressure sores) and even pre-mature death (Eide and Øderud 2009, Shore and Juillerat 2012, Øderud 2014, Ribeiro, Hasten-Reiter Junior et al. 2015). In addition, lack of AT access often increases the burden on caregivers and reduces social and economic potential of the household (WHO 2018a).

The World Health Organization (WHO) estimates that between 5-15% of those who require AT worldwide currently have access and that the global need for AT will grow to 2 billion by 2050 due to changing global demographics (WHO 2018a). The increase in people with chronic conditions, non-communicable diseases such as diabetes and the aging of the global population, will result in more people with functional limitations who may benefit from AT (Murray, Vos et al. 2012, Woolf, Erwin et al. 2012, Marasinghe, Lapitan et al. 2015, Ennion and Johannesson 2017). Improvements in trauma care in LMICs is also likely to result in an increased need for AT. Trauma is a leading cause of disability and death (WHO 2014) and as trauma care improves there will be more people who survive injuries or violence and experience short or long-term disabilities. Injuries caused by road accidents that result in disabilities are common and increasing in LMICs. Between 2000 and 2016, the years lost due to disability caused by road injuries increased by 70% (WHO 2016a).

Many who will need AT require more than one AT product (WHO 2018a). For example, an older adult who is recovering from a stroke may benefit from multiple devices that will help them walk around the home (walker), communicate with family members and health professionals (speech amplifier) and remember when to take medications (pillbox with timer).

Unmet needs most commonly cited focus on people with mobility, vision, and hearing limitations (WHO 2018a). Outside of traditionally identified disabilities that are often associated with the need for AT, advancements in technology and the evolving concept of 'disability' translate into AT benefitting a much larger population. For example, children with autism and people of all ages with behavioural health issues (post-traumatic stress disorder, depression) are using AT (Wallace, Hayes et al. 2000, Nkabinde Zandile 2008, Natasha, Casey et al. 2019).

New strategies are under development worldwide to address this large and growing unmet need. Actors in this field work to address AT needs from public health, global development and human rights perspectives. The need for AT globally has also been presented as an opportunity for rapid market expansion to address unmet demand. Market research companies estimate that the AT global market from will grow from $14 billion in 2015 to between $26 - 31 billion by 2024 (Bureau of Internet Accessibility 2019). The discourse of new initiatives seeking to stimulate global AT market growth includes 'market shaping' and 'disruptive technologies'. These initiatives are modelled after successful market-based strategies applied for other types of essential products such as vaccines (MacLachlan, McVeigh et al. 2018, ATscale Global Partnership for Assistive Technology 2019).

The WHO is taking a leading global role in advocating to increase access to high-quality and affordable AT. The WHO Global Cooperation on Assistive Health Technology initiative (GATE) was launched in 2014 and aims to provide global leadership to 'catalyze change' by establishing and monitoring international policies and standards, promoting research and knowledge translation and building strategic global partnerships (WHO 2015). One such partnership is AT2030 that aims to reach 500 million people globally with life-changing AT (Albala, Holloway et al. 2019). In May 2016 GATE launched the Priority Assistive Products List (APL), which includes a list of minimum 50 products selected on the basis of widespread need and impact on people's lives (WHO 2016b). The APL is designed to not be restrictive, but instead to encourage countries to develop their own list of national priority products. It is anticipated that these national lists will enhance production, procurement and service provision, and be used to develop reimbursement policies and stimulate market AT growth.

There are numerous international policy instruments that align with the efforts of GATE. Within these instruments, access to AT is recognized as critical to achieving global health agendas and the rights of persons with disabilities (United Nations 2006, WHO and World Bank 2011, Team 2014, WHO 2017b). The United Nations Convention of the Rights of Persons with Disability (CRPD), adopted in 2006, addresses AT in multiple articles (Articles 4, 20, 26 and 32) – covering the promotion of research, development, production, availability and appropriate use of AT (United Nations 2006). As of November 2019, 180 countries have ratified the CRPD, thus committing to the

national implementation and participation in monitoring and supervision procedures to support compliance (Lord, Suozzi et al. 2010). Yet, it is important to note that the level to which the CRPD has been domesticated into national policies and implementation differs substantially among ratified countries (Dziva, Shoko et al. 2018, Tigere and Moyo 2019).

The most recent and prominent global AT policy tool is the World Health Assembly (WHA) resolution 71.8 (WHO 2018b). The WHA71.8 addresses AT across all major health and development sectors covered in the 17 Sustainable Development Goals (SDGs). Access to AT is viewed as essential to achieving all 17 SDGs and that the exclusion of AT will inevitably be discriminatory towards persons with disabilities (Tebbutt, Brodmann et al. 2016, WHO 2018b). 'Disability' is referenced in many of the social, economic and environmental SDGs because people with disabilities are among the most vulnerable populations worldwide. Persons with disabilities are more likely to be poor; at greater risk of morbidly and mortality due to conflict or natural disasters; have poorer health; and less access to health care, educational and employment opportunities than people without disabilities (WHO and World Bank 2011, WHO 2018b).

While there is substantial momentum within the global AT community to mobilize resources and design strategies to address the growing unmet need/demand for AT within resource limited environments (RLEs), the lack of AT evidence in RLEs is a major challenge to advancing this nascent field. In a review of research publications on AT in RLEs it was found that 'there is a general lack of evidence to support effective implementation of the required AT measures of the CRPD' p.25 (Borg, Lindstrom et al. 2011). Borg et al. found that the available research is primarily product-oriented and fails to address system level issues such as service delivery to ensure AT is available and affordable. At a 2019 GATE event, one presenter reported on the review of 49 studies on AT service delivery programs from low resourced settings and concluded by stating that none had been evaluated for effectiveness so 'we don't know what works' (de Witte 2019). In the absence of evidence on what works to increase AT access, global strategies are modelled off other sectors. For example, the APL developed by GATE follows the essential medicines model (WHO 2016b). While this approach may have been effective in rapidly increasing access to essential medicines, there are numerous idiosyncrasies about AT that may not apply. The heterogeneity in AT product characteristics, uses and beneficiaries create a more complex landscape than found in the field of medicines. AT also operates within a wide range of settings and sectors (not exclusively health), with unique policies and practices for product procurement and provision.

What is known is that the AT sector within RLEs (i.e., Southern Africa) is characterized by inadequate financing, a shortage of trained AT personnel and services and the lack of policies and regulations (Mukherjee and Samanta 2005, Gupta, Castillo-Laborde et al. 2011, WHO and World Bank 2011). In

Southern Africa, production, procurement and provision of AT is limited and repair services are nearly absent (Visagie, Eide et al. 2017). Of the limited amount of AT provided, products are often not suitable for the individual and/or environment which can led to abandoned devices (Visagie and & Schneider 2013, Visagie, Mlambo et al. 2015). Lack of government support to fund AT and AT related services is cited as the primary reason for the large unmet need (Bozzani, Griffiths et al. 2014, Ennion and Johannesson 2017, Visagie, Eide et al. 2017). International donors play a significant role in funding and providing AT in many Southern African countries, either free or at a reduced price. Yet people still face numerous barriers to accessing these devices including lack of awareness, inaccessible transportation, social stigma and discrimination, cultural beliefs, cost of AT and proximity of providers (Magnusson, Ahlstrom et al. 2013, Thompson, Naidoo et al. 2015, Vergunst, Swartz et al. 2015, Govender and Khan 2017, Hanass-Hancock, Nene et al. 2017, Visagie, Eide et al. 2017).

In Southern Africa, most AT research is fragmented by type of AT or setting and does not address system-level issues that limit or delay AT access. Most AT research in Southern Africa focuses on user outcomes and service delivery, meaning AT experiences of professionals and end users who provide and receive AT. For example patient satisfaction, clinical and functional outcomes have been studied for those who accessed lower-limb prosthetics (Sexton 2015, Magnusson and Ahlström 2017), locally made wheelchairs (Amosun, Ndosi et al. 2016), spectacles (Pillay, Chan et al. 2016), and for those with spinal cord injuries (Topaloff 2015, Löfvenmark, Hasselberg et al. 2017). Studies that address service delivery focus on parts of provision but not AT provision as a system (e.g., assessing AT needs of school age children with speech impairments and AT selection (Dada, Murphy et al. 2017)). The gaps in AT provision identified are often at the surface level (e.g., lack of trained AT personnel, high cost of AT, lack of government funding) and lack in-depth analysis of why these gaps exist (Ennion and Johannesson 2017, Visagie, Eide et al. 2017, van Niekerk, Dada et al. 2019).

The current evidence base on AT from Southern Africa fails to explore and characterize lack of AT access from a systems-perspective or explain the underlying causes. For the most part, existing studies target those who received AT, not the larger population that lacks access. This limited understanding of how AT systems operate to increase access and what is unique to the Southern Africa region is likely to result in ineffectual piecemeal interventions.

This recent boost in global efforts to increase AT access is remarkable and harnessing this momentum for the benefit of Southern Africa will require a comprehensive understanding of the very complex, fragmented and under-resourced AT sector within this region.

My PhD research was guided by the overarching research question: What works to increase access to assistive technology in Southern Africa? The language I selected, 'what works', speaks to my intent to not only explore and describe the many deficits and challenges within the AT sector, but to approach this study in a manner that guides future interventions to increase AT access. This orientation will be achieved by explicitly asking about solutions during interviews (i.e., What interventions have been implemented to increase AT access?) and conducting analysis that pinpoints primary system-level bottlenecks to increasing supply and access. These bottlenecks then become the foci of strategic interventions. The original geographical scope defined for Southern Africa was the 16 countries that comprise the Southern African Development Community (SADC)[1] though most data addressed the AT systems within Botswana, South Africa, Swaziland and Zimbabwe. Findings, conceptual models and subsequent recommendations may be applicable to other RLEs worldwide.

1.2 DEFINING ASSISTIVE TECHNOLOGY

Assistive technology (AT) includes a wide range of products (often called devices or aids) that are used to improve and individual's functioning such as mobility, hearing, vision, speech, learning and cognition. Examples of AT include speech-text software, large print books, hearing aids, walkers, wheelchairs, grab bars, prosthetic limbs, seating and positioning supports, and eye glasses. While there is a lack of international agreement on criteria for determining what is AT, one commonly used definition is, 'Any item, piece of equipment or product system, whether acquired commercially, off-the-shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities' (United States Congress 2004). This definition of AT was initially selected for this doctoral study because it was used within the World Report on Disability, a landmark global report that aimed to capture the best scientific evidence available and guide national and international action.

After the initiation of this doctoral study in 2014, the definition and taxonomy of AT continued to evolve by international standard setting organizations (i.e., the WHO and International Organization for Standardization). WHO GATE developed the following new definition: 'any product (including devices, equipment, instruments and software), either specially designed and produced or generally available, whose primary purpose is to maintain or improve an individual's functioning and independence and thereby promote their well-being' (Khasnabis, Mirza et al. 2015). It is noteworthy that this newer definition does not include the term 'disability' and thus can serve to help the

[1] SADC is a Regional Economic Community that current include 16 countries: Angola, Botswana, Comoros, Democratic Republic of Congo, Swaziland, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia and Zimbabwe.

general public understand the broad range of populations that may benefit from AT. For example, people with HIV, back pain, or arthritis may not consider themselves or be viewed as having a disability but do experience functional limitations that can be addressed by AT. Likewise, the International Organization for Standardization (ISO) revised the AT product standards between 2011 and 2016 (International Organization for Standardization 2016). The role of ISO is to establish product standards to harmonize industries globally.

Underpinning both GATE and ISO updated definitions is the International Classification of Functioning, Disability and Health (ICF). The ICF framework describes 'disability' as combination and interaction of impairments (body structures and functions), personal factors and environmental factors (Gunawardena, Seneviratne et al. 2004). The ICF has helped shift the understanding of AT away from 1) a product that treats a problem with the body (medical model), towards 2) a product that improves functioning and increases participation. Improving functioning and increasing participation often depends of the accessibility of the environment (e.g., social, built), and this interaction between the individual and society is often referred to as the social model of disability. This ICF framing broadens the scope of AT, in terms of potential end users, product types and uses.

The changing nature of the definition of AT reflects the infancy of the field and posed a challenge for carving out boundaries for this doctoral study. It also alludes to one recommendation generated through this study – to increase conceptual uniformity. Given the evolving disability concept and AT definitions, developing a strict set of criteria for AT was not realistic for this study. Thus, the following categories of AT were identified as a starting point for capturing the scope of AT:

- Mobility devices such as wheelchairs, crutches, prosthetics and orthotics.
- Visual devices and aids such as contact lenses, spectacles and low vision aids.
- Hearing devices such as hearing aids, loops and batteries.
- Daily living aids such as bathing chairs, adaptive utensils or tools.
- Communication aids such as deafblind communication system or communication boards.
- Cognitive aids such as pill organizer or GPS locator.
- Accessible information and communication technologies, including computer and mobile based hardware, software and related equipment designed specifically for persons with disabilities such as an alternative input device for a person with limited hand mobility. This category overlaps with many of the other product categories.
- Environmental adaptations or accessibility features such as ramps, home modifications, or accessible public services such as accessible transportation or public facilities.

This general and flexible list of categories allowed for new AT products to emerge that are unique to Southern Africa. For example, during the course of research, sunscreen was identified as AT as it is medically necessary for people with albinism who are protected as persons with disabilities in many Southern African countries (Visagie, Matter et al. 2018).

Types of products that are commonly not considered AT and were excluded from this study include:

- Medical devices and supplies: This broad category of products serve medical purposes such as diagnosis, prevention and treatment (therapeutic and surgical) (WHO). AT generally does not include diagnostic or monitoring devices, implants (e.g., cochlear) or endoprosthesis (e.g., hip or joint replacement), or all instruments and devices used for surgical treatment.
- Non technology services: Examples include lip-reading, sign-language or guide dogs.

AT is provided within multiple settings (e.g., health, education, employment) though most data generated in this doctoral study referenced health settings. The World Report on Disability presents AT as provided within the health system, specifically as a component of rehabilitation services, while acknowledging that AT may be provided within the education or employment settings (WHO and World Bank 2011). The WHO describes rehabilitation services as serving to prevent the loss of function, slow the rate of loss of function, improve or restore function, compensate for lost function and/or maintain current function (WHO and World Bank 2011). In other WHO publications, AT is often referred to as a health product (WHO 2017c). This can minimize attention given to types of AT that are not typically provided by the health system such as an adaptive writing device or screen reader.

1.3 GUIDING CONCEPTUAL FRAMEWORK OF INCREASING AT ACCESS

Existing definitions and conceptual frameworks were adapted that guide the design of this research study. Key concepts within this framework are introduced below.

Access

There are numerous definitions and frameworks used to capture the meaning of the complex concept ‘access’. Peters’ (2008) definition of access, ‘the timely use of services according to needs’ that is often cited in the health services and systems literature was applied in this PhD research study with the caveat that the term ‘services’ equates to AT (Peters, Garg et al. 2008). ‘Timely’ indicates that access is not only about receiving or not receiving AT but how quickly one receives AT. ‘According to needs’ resonates with the concept of ‘appropriate AT’ that is commonly used language within the AT field. Appropriate AT is defined by the WHO as ‘assistive technology which suits the

need of the individual and their environment and can be available and maintained in the country at an affordable price' (Khasnabis 2013).

There is agreement in the literature that 'access' is multidimensional and some dimensions (i.e., availability and affordability) are commonly included in conceptual frameworks. Yet there is no consensus as to which dimensions and corresponding definitions are most comprehensive or appropriate for different aims of inquiry. Six dimensions of AT access are described in the WHO Joint Position Paper on the Provision of Mobility Devices in Less Resourced Settings (WHO 2011) (Table 1.1). In these descriptions, access dimensions are placed within the disability context. For example, the 'accessibility' dimension below includes physical accessibility such as a ramp for a wheelchair user and information accessibility such as a large print text for someone with low vision.

Table 1.1 Six dimensions of AT access

Dimensions	**Definitions**
Accessibility	Mobility devices and related services are accessible to everyone with an identified need. Accessibility encompasses nondiscrimination, physical accessibility and information accessibility. Provision of mobility devices should be equitable to avoid discrepancies between genders, age groups, impairment groups, socioeconomic groups and geographical regions.
Affordability	Mobility devices and related services must be affordable for people with disabilities and their families, particularly in low-resource settings. Affordability refers to the extent to which people can pay for the device and/or services associated with it.
Availability	All relevant resources (health-care facilities, programs and services, human resources, materials and products) required for the provision of mobility devices are available in sufficient quantity for the needs of the population and are provided as close as possible to people's own communities.
Acceptability	People with disabilities are actively involved in all stages of mobility device provision, having choice and control over the decisions that affect them. Factors such as efficiency, reliability, simplicity, safety and aesthetics should be taken into account to ensure devices and related services are acceptable to users.
Adaptability	Mobility devices and related services are adapted and modified to ensure they are appropriate to the requirements of the individual. They consider all aspects of the individual's disability, i.e. impairments, activity limitations, participation restrictions, related health conditions, environmental factors (e.g. physical and social environment) and personal factors (e.g. gender, age, race, physical fitness, lifestyle and habits).
Quality	All relevant resources (health-care facilities, programs and services, human resources, and materials and products) are of an appropriate quality. Product quality can be measured through local, national and international technical standards or guidelines in terms of strength, durability, performance, safety, comfort, etc. Specific qualities of services can be measured in terms of compliance with staff training requirements and service guidelines (WHO, 2008a). The overall quality of services can be measured in terms of outcomes, user satisfaction and quality of life. Resource constraints, and particularly the issue of affordability, should not necessarily compromise the principle of quality.

The phenomenon of 'increasing access to AT' refers both to the experience of an individual in gaining access to AT and to broader system-level increases in AT access. System-level increases would be measured by increased supply of products and services (quantity and range), wider geographic coverage of AT provision and the reduction in unmet AT needs.

AT system

AT specific frameworks were explored yet none were suitable to address the structural components that influence access such as policies and financing; or account for the multidimensional nature of access. Existing frameworks primarily focused on AT provision (e.g., person-centered assessments) and AT service delivery systems (e.g., ensuring maintenance services of AT) (EASTIN and AAATE 2012, Elsaesser and Bauer 2012, Cook and Polgar 2014). These frameworks were developed in the context of high resourced settings were AT is more available than in lower resourced countries.

It was anticipated that the phenomenon of 'AT access' would have challenges that were common within parallel fields focused on less resourced contexts, specifically access to health care and health products such as medicines and medical devices (Jacobs, Ir et al. 2012, Bigdeli, Javadi et al. 2013). In a 2013 article on access to medicines (ATM), the author questions why ATM in LMICs has only 'partially improved' given the extensive amount of research conducted (i.e., 648 studies between 2003-09) and investments made in improving practice (Bigdeli, Jacobs et al. 2013). Bigdeli et al. proposes a health systems perspective to capture the complexities and holistic nature of ATM and address the 'shortfall' in current research approaches that are often limited to examining sub-components within the health system (e.g., supply of medicines). A 'systems thinking' perspective, speaks to the reality that systems are non-linear, complex, adaptive and dynamic. As stated, 'systems thinking is, foremost, a mindset that views systems and their sub-components as intimately interrelated and connected to each other, believing that mastering our understanding on how things work lies in interpreting interrelationships and interactions within and between systems' (Adam 2014), p. 3. Adopting a systems perspective to address the global need for AT has also been advocated for by leaders within the WHO GATE initiative (MacLachlan and Scherer 2018).

Given the absence of a system-level framework for AT access, the ATM conceptual system proposed by Bigdeli et al. was selected and adapted for this study. The development of this ATM framework was based on the review and integration of previously developed frameworks that focused on access to medicines. Bigeli's framework includes five dimensions of access, six building blocks of the health system and five levels of the health system (Bigdeli, Jacobs et al. 2013). In line with this framework and the broader health systems literature, challenges or gaps within the AT system will also be referred to as system weaknesses that can then inform system strengthening strategies.

Dimensions of AT

The five dimensions of access (availability, accessibility, affordability, acceptability and quality) conveniently correspond with those found in an WHO joint position paper, with the exception of *Adaptability* (WHO 2011) (Table 1.1). Given that Bigeli did not provide definitions for the five dimensions of access listed with the ATM framework, the WHO six dimensions and definitions that are specific to AT were applied for this study.

Health system building blocks

Bigeli's framework includes six building blocks of the health system (medicines, health information, health financing, human resources, health infrastructure and governance). Building blocks have been presented with many subtle variations in the health systems literature. Six building blocks of health systems that were defined by WHO are commonly cited and fairly consistent with those within the ATM framework (WHO 2007). Table 1.2 compares the ATM and WHO health systems building blocks and shows the modifications made to capture the AT system. One modification was removing 'health' from the terminology as AT can be accessed in a variety of settings. Another modification was labelling 'health infrastructure' and 'service delivery' as 'provision' as AT access requires the provision of products and related-services (e.g., assessments).

Table 1.2 Comparing building blocks across frameworks

ATM building blocks	**WHO health systems building blocks**	**AT system building blocks**
Medicines	Medical products, vaccines and technologies	Assistive technologies
Health financing	Financing	Financing
Human resources	Health workforce	Human resources
Health infrastructure	Service delivery	Provision
Governance	Leadership/governance	Policies
Health information	Information	Information

Levels of the health system

The final conceptual element within the ATM framework are the levels of the health systems (Table 1.3). These levels were used to distinguish where factors (facilitators and barriers) operate, from the individual to the international level (Bigdeli, Jacobs et al. 2013). Again, health system was expanded to include other non-health sectors for these five levels within the AT system (right column).

Table 1.3. Levels of the health system and AT system

Health system levels	Description	AT system levels
Level 1: Individuals, households and communities	Cost of services, perceived quality of services, or social barriers to accessing services such as stigma.	Level 1: Individuals, households and communities
Level 2: Health service delivery	Availability and quality of services, prices, and interaction between public, private, informal sectors	Level 2: Provision
Level 3: Health sector level	Governance that regulates financing, human resources, products such as regulations, procurement distribution, licensing, quality control	Level 3: Sector level (e.g., health, education)
Level 4: National context	Bureaucracy, corruption, level of public accountability, level of priority	Level 4: National context
Level 5: International context	Donor agendas and funding, international market forces, international laws (e.g., intellectual property rights) and standards	Level 5: International context

Applying the conceptual framework to AT access

The basic components and underlying perspectives within this ATM framework aligned with the AT sector, though there are clear distinctions related to AT. Unlike medicines AT products vary substantially in physical attributes, how they are used, points of distribution and in the diversity of personnel involved in services and distribution. While AT products require regulations and enforcement to ensure safety and quality of products and related services, this task is more complex than medicines due to the multisectoral nature of AT and the wide range of product types. Specifically, mobility devices such as wheelchairs are most suited for delivery within the health system while cognitive, learning and communication aids may be provided in educational or employment settings. The type and complexity of product and provision regulations differ by product type. For example, the umbrella term 'AT' captures both off the shelf bifocals that a consumer can purchase from retail shops and customized prosthetic limb that requires highly specialized health professionals to provide.

Perhaps the most striking difference when comparing AT access to ATM in Southern Africa is that many AT products are embedded in a 'disability' context and networks of disability organizations. Local disability persons organizations (DPOs) and international disability focused non-governmental organizations (NGOs) such as CBM (https://www.cbm.org/) have been involved in AT provision in Southern Africa for decades, sometimes serving as the primary supplier of AT within countries that have minimal government support. Given that DPOs were primarily established to address the persistent marginalization and discrimination experienced by people with disabilities, the advocacy role played by these organizations can be a key factor in obtaining AT, both by overcoming individual

barriers such as a lack of awareness and by advocating for increased availability of AT. Social stigma also influences who gets access to AT. For example, someone with acquired mobility impairment due to a car accident may suffer from less social stigma and discrimination than someone born with a congenital condition that limits mobility. Both individuals may require the same AT and represent similar demographics but will face different barriers due to social stigma, as the person with the congenital conditions may be perceived as 'bad luck' or cursed. The level of discrimination can also differ by type of AT. For example, a parent of a child with visual and mobility impairments may easily accept their child's needs for eye glasses but are reluctant to address their child's need for a wheelchair due to the discrimination that can accompany being 'seen as disabled'.

The modified ATM conceptual framework (Tables 1.2 and 1.3) was combined with relevant descriptions from the AT and disability context to inform the research questions, design and analysis. First, 'access' was refined to mean timely access to appropriate AT. Second, understanding what works to increase AT access required an exploratory research approach to allow for the multiple access dimensions, building blocks and system levels (e.g., global, national) to emerge. This meant, incorporating quantitative and qualitative methodologies that would provide a broad understanding of the AT landscape as well as opportunities for more in-depth examination of key barriers and facilitators to AT access. Finally, this modified framework encouraged me to go beyond the obvious surface levels explanations such as inadequate AT financing and examine the relationships between the multiple factors that determine AT access. Based on the study findings, this initial framework was further modified to reflect the key components and characteristics of the AT system specific to the Southern African context.

1.4 RESEARCH QUESTIONS AND OBJECTIVES

The overarching question that guided the design of my doctoral research was: <u>What works to increase access to assistive technology in Southern Africa?</u>

In my effort to answer this question, two primary research questions were explored through three sub-studies. The first question, w*hat are the facilitator and barriers to AT access*, aimed to identify a catalogue of factors that can help explain AT access. The second question, *how do factors identified interact with each other and the broader context to increase access to AT?,* aimed to build a theory of AT access through prioritizing factors and understanding the relationships and mechanisms that explain how and why these factors operate. The primary and secondary objectives of this doctoral study are listed below.

Primary objectives:

- Increase understanding of how various components, processes and actors within the complex landscape of AT interact to result in increased AT access in Southern Africa.
- Develop a theoretical model to inform practice and policy strategies required to increase AT access.

Secondary objectives:

- Identify conceptual and methodological challenges involved in conducting research on AT access such as the lack of agreement on key concepts (e.g., definition of assistive technology).
- Inform future research priorities through identifying gaps in the evidence base and salient research questions that emerge through the study.

The AT system framework was applied to understand the phenomenon 'AT access' within Southern Africa, as described in Section 1.3 on the guiding conceptual framework.

CHAPTER 2 METHODS

In this chapter I outline that overall study design and specific methods used for data collection and analysis for the three sub-studies that comprised my doctoral research.

2.1 OVERVIEW

Three sub-studies were conducted to identify and describe the facilitators and barriers to AT access and increase the understanding the complex arrangement of factors that affect AT supply and access in Southern Africa. Sub-studies were conducted in a sequential manner, allowing each approach and results to inform revisions in the design and analysis of the next study.

The doctoral study began with a broad level **scoping review** that served to identify and characterize existing evidence on AT from resource limited environments.

Next, a **secondary analysis** of existing national survey data from two countries in Southern Africa (i.e., Botswana and Swaziland) was conducted to examine sociodemographic factors associated with AT access.

Finally, the **qualitative sub-study** served to increase the understanding of how barriers and facilitators to AT access (factors) operate to increase access to AT in Southern Africa. A case study approach was applied to gather and analyse multiple sources of data including stakeholder interviews; AT documentation from national, regional and international sources (e.g., policies, initiatives); and observations. The qualitative study was the most comprehensive in breadth and depth among the three sub-studies, yielding the bulk of findings pertinent to the research questions and objectives.

Rationale for three sub-studies

The three sequential sub-studies allowed for triangulation and in a rich understanding of the complex phenomenon of study - AT access. I approached this research from a post-positivist perspective, applying both quantitative and qualitative methods and multiple data sources, to identify and test emerging interpretations in a rigorous way (Ryan 2006).

Sub-study 1, the scoping review, was initiated as part of a WHO funded contract to inform the development of Guidelines on Health-Related Rehabilitation. Additional analyses and writing of the article for the doctoral study was conducted with guidance from my PhD supervisor. The process of designing, conducting and analysing data for the scoping review proved invaluable in framing the

overall doctoral study. Specifically, defining the range of AT, potential end users of AT and diverse associated topics became the subject matter boundaries for the study.

Of the studies included in the scoping review most had a narrow focus area (i.e., wheelchairs) and thus did not address AT as a 'system'. In the absence of research that covered a broad range of AT, the subsequent two sub-studies drew upon on fragmented AT evidence and system-level research from parallel fields. Conceptual challenges in the field of AT also emerged in this sub-study which were handled through drafting a typology of themes that were informed by the system-level components described in the modified ATM framework (see Section 1.3).

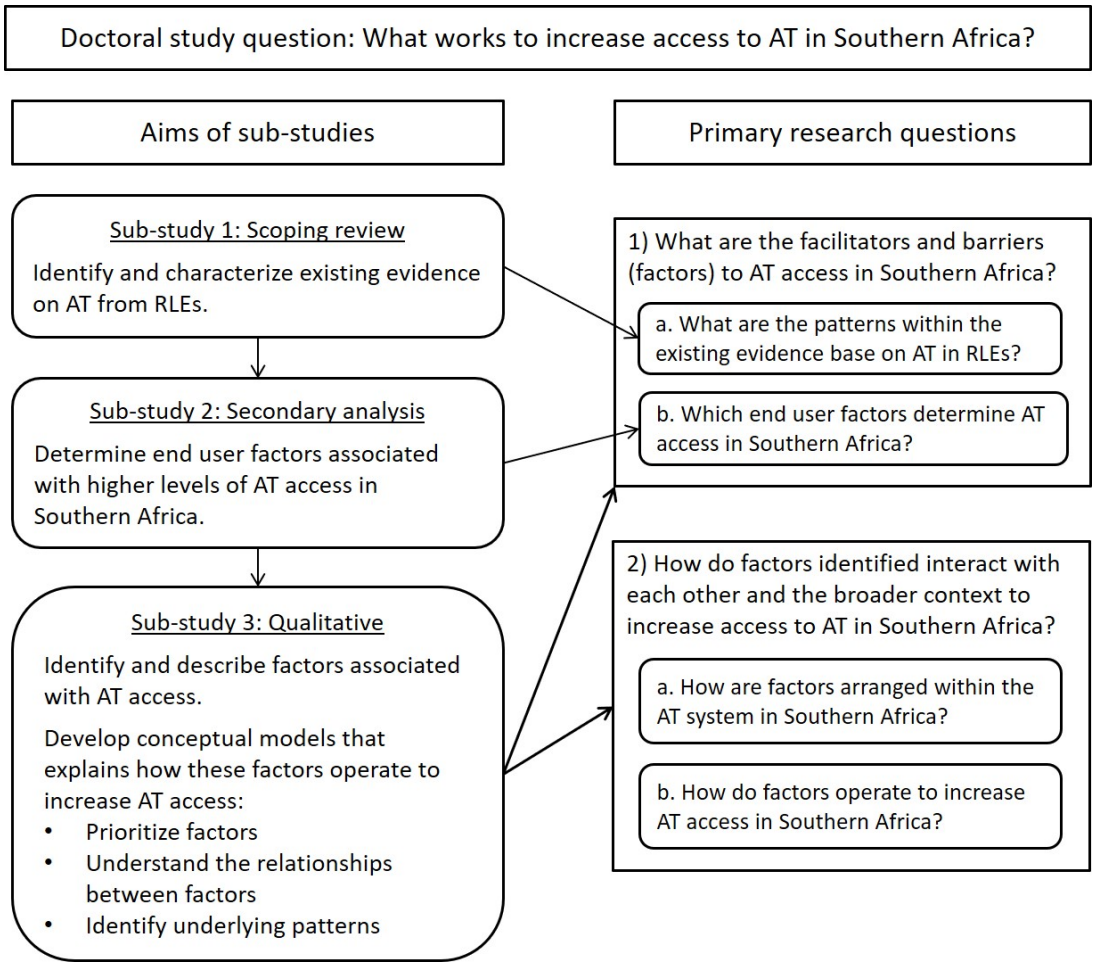
The process of conducting sub-study 2, the secondary analysis of national survey data, began with the review of the subset of studies from the scoping review that addressed AT within Southern Africa to identify and prioritize potential factors associated with AT access. Factors included demographics, disability status and socioeconomic variables of end users. The national survey datasets analysed from Botswana and Swaziland were about end users and from the perspective of end users, not that of other actors within the AT system. The examination of end user factors was explored further from the perspective of providers, manufactures and suppliers in the qualitative sub-study.

Findings from both the scoping review (sub-study 1) and secondary analysis of survey data (sub-study 2) were used to refine the research questions and approach for the regional qualitative sub-study. The findings from the scoping review validated the common perception that the evidence base on AT in RLEs is limited in quantity and quality. If the evidence identified through the scoping review had been more robust in quality, quantity and scope (range of AT types, addressing system-level issues), the approach for the qualitative sub-study would have been less exploratory. Instead, the scoping review illuminated the need for flexibility in methods applied for the qualitative sub-study. The secondary analysis brought to light a key finding regarding the dominance of mobility devices within the AT sector, emphasizing the importance of both learning how mobility devices become more available than other types of AT and including stakeholders who had expertise in non-mobility types of AT.

The regional qualitative sub-study sought to examine the AT sector as a whole and relied on key informants and other data sources that represented different parts of the sector. A more holistic picture was achieved through gathering data that covered different AT types, sectors (government, for-profit, non-profit), settings (e.g., health, education), countries and roles (direct service provider, leadership, suppliers/manufacturers). In applying a systems framework, the qualitative sub-study was designed to describe and understand the inner workings of the complex phenomenon of AT

access. This qualitative sub-study served to generate most data used to answer the two primary research questions: w*hat are the facilitator and barriers to AT access?* and *how do factors identified interact with each other and the broader context to increase access to AT?* Research aims and questions that were addressed by each respective sub-study are presented in Figure 2.1.

Figure 2.1 Sub-study aims and research questions



As shown above in Figure 2.1., the two of sub-studies (scoping review and secondary survey analysis) address sub-questions related to the first primary question. The third and most robust sub-study addresses both primary questions.

2.2 SCOPING REVIEW OF ASSISTIVE TECHNOLOGY EVIDENCE IN RESOURCE LIMITED ENVIRONMENTS

The research sub-question addressed by the scoping review was: *1a. What are the patterns within the existing evidence base on AT in RLEs?*

The scoping review characterized the evidence base on AT in RLEs through applying a systematic process for identifying and analysing relevant studies, in line with commonly applied methods (Grant

and Booth 2009). The approach was broadly inclusive, covering studies on a diverse range of AT types and geographical areas that were classified as RLEs. RLEs were defined as 'a geographical area with limited financial, human and infrastructural resources to provide rehabilitation (a common situation in low- and middle-income countries, but also in certain areas of high-income countries)' (WHO 2012a). The results of this analysis included descriptions of the strengths and weaknesses within the evidence base and conceptual challenges involved when conducting evidence reviews in the complex and evolving field of AT.

The methodological framework developed by Arksey, et al. guided the process applied in this scoping review (Arksey and O'Malley 2005). Strategies were outlined in a development plan that was drafted by lead researchers and then refined based on feedback from an international panel of experts. This plan included goals of conducting the scoping review, study population, inclusion & exclusion criteria, key literature terms and literature sources to search. The four broad steps followed included 1) searching, 2) screening, 3) extraction and 4) analysis.

This sub-study yielded a summary of research publication attributes including topics of research (AT types, regions), study design, sample size and year. AT types were categorized into five domains to capture the activity limitations (i.e., mobility) and these domains were then compared across years, regions and study designs, that were presented with data visualizations.

Recommendations addressed weaknesses identified in the existing evidence base and informed strategies for conducting future evidence review to characterize and synthesize AT research literature.

Detailed methods for the scoping review are outlined in Section 3.2 because Chapter 3 is the published paper.

2.3 SECONDARY ANALYSIS OF NATIONAL REPRESENTATIVE SURVEY DATA FROM BOTSWANA AND SWAZILAND

The research sub-question addressed by the secondary analysis was: *1b. Which end user factors determine AT access in Southern Africa (i.e., Botswana and Swaziland)?*

This sub-study served to identify end user factors associated with access to AT in the two countries Botswana and Swaziland. Types of end user variables included demographic, socioeconomic and disability status (i.e., type and level of severity).

Logistics regression techniques were applied to a subset of cases (individuals) and variables from two Living Conditions Studies (LCS), nationally representative surveys that were conducted in

Botswana (2012-14) and Swaziland (2009-10). LCS were designed to capture a wide range of social and economic living conditions of people with disabilities. These surveys measured basic socioeconomic status and the degree to which people with disabilities participate in major life activities (i.e., education, employment, community) and realize their human rights, including the right to health care and AT (Eide 2014).

The target sampling populations for LCS were all private households, excluding people who were homeless or institutionalized. Cases selected for inclusion in the secondary analysis were individuals with disabilities 15 years of age or older who reported needing AT devices. The dichotomous outcome variable was having received or not received AT. Potential explanatory variables were identified based on AT and health services literature from Southern Africa. Variables selected included demographic, socioeconomic and disability status. A statistical (stepwise) logistic regression approach with a bivariate association criterion of $p < .20$ was used as it was not possible to develop a specific hypothesis from the limited evidence base. SPSS Statistics 24 software was used for all statistical analysis. Results included a presentation of factors that were positively and negatively associated with AT access and full statistical models that showed strength of association.

Detailed methods for the secondary analysis of national survey datasets for Botswana and Swaziland are outlined in Chapter 4, Section 4.2. Chapter 4 is the published paper of sub-study 2.

2.4 REGIONAL QUALITATIVE SUB-STUDY

Unlike the methods of the first two sub-studies that are detailed within each of the study publications presented as Chapter 3 and 4, the full methods for the third sub-study are described below. This qualitative regional sub-study has not been published and was the largest and most comprehensive of the three sub-studies.

The qualitative regional sub-study addressed the two primary research questions.

1) *What are the facilitator and barriers to AT access in Southern Africa?*
2) *How do identified factors interact with each other and the broader context to increase AT access in Southern Africa.*
    a. *How are these factors arranged within the AT system in Southern Africa?*
    b. *How do these factors operate to increase AT access in Southern Africa?*

The first questions served to catalogue a list of factors. The second question aimed for a comprehensive understanding of how these factors operate to increase AT access.

The following description of the qualitative sub-study methods includes the overall design, description of three types of data collected, and approaches to data management and analysis.

Design

This qualitative sub-study utilized case study methods in order to understand the complex subject, AT access. Case studies aim for a holistic or complete understanding of real-world phenomenon by relying on multiple data sources, a range of perspectives and approaches to analysis (Yin 2014).

The sub-study questions outlined included:

- Who does and doesn't have AT access and why?
- What are the primary challenges or bottlenecks to increasing AT access?
- What interventions have been implemented to increase AT access? Why did these interventions work/not work to increase AT access?
- Which stakeholders are critical in increasing AT access? Why and how?
- What other resources (financing, human resources, information, etc.) are needed to increase AT access?
- What processes of procuring and providing AT are needed to facilitate increased AT access?
- Which contextual factors (national, regional, international) enable AT access? Why and how?

These questions aimed to explore unmet AT needs, identify constraints within the AT systems (e.g., lack of funding), understand operational aspects (e.g., role of different actors, processes for procurement and provision) and broader factors not specific to the AT system that may influence AT access (e.g., cultural norms or global trade dynamics).

The three data sources collected to address these questions included:

1) Stakeholder interviews from actors in the AT sector in Southern Africa
2) Review of relevant AT documentation (e.g., policies, standards, initiatives, strategies)
3) Brief observations that took place as part of stakeholder interviews or AT initiatives

A detailed description of each of these three data sources are provided below.

1) Stakeholder interviews

Interviews were conducted in order to gather rich data from stakeholders that represented the full range of viewpoints on AT access in Southern Africa. Interviews used a semi-structured process in order to allow for new topics to emerge, and for me to have the flexibility to follow the participants' line of thinking as a way to gain a deeper understanding. For example, a participant who had experience with medical aid funding of AT may warrant spending more time focused on that topic during the interview. Another benefit of the semi-structured process was that the meaning of fundamental concepts within the study such as 'AT supply and access' were determined by the participant. The interview guide was designed to provide starting points to the conversation and

ensure the core research questions were addressed but questions were not necessarily followed sequentially, or all covered during each interview. The interview guide and consent form are provided in Appendix C.

Sampling and recruitment

Participants were selected through both purposive and snowball sampling to ensure the group represented variations in sectors (public, non-profit, for-profit), AT types, roles and countries of experience. The original sample goal was 20 participants. This number was proposed as sufficient to provide representation of the sector and address the research questions and aims of the study.

The criteria for participation in an interview was having experience and knowledge of the AT sector in one or more countries in Southern Africa. Types of experience included:

- Providing AT directly to end users
- Manufacturing, supplying or procuring AT
- Engagement in activities that support AT access such as policy making, advocacy, information and referral and training
- Researching AT sector in Southern Africa

Two sources were the starting point for recruiting interview participants:

- AT-Info-Map networks that included a broad range of AT stakeholders in Southern Africa. The AT-Info-Maps project (2016-19) established network included AT manufacturers, suppliers and providers; disability organizations (DPOs); and academics/researchers. The aims and scope of this project is described in detail in Box 2.1.
- Professional contacts from previous research I conducted on local rehabilitation workshops in Zimbabwe.

A matrix was developed to track characteristics of participants (AT type, countries of experience, roles, sector) and used to purposively recruit to fill the gaps. Contacts within existing networks and research participants were asked to identify additional potential stakeholders to recruit. Two individuals were recruited through a Google search to identify large for-profit suppliers in non-mobility category of AT, one of the gaps that was not filled through snowball sampling.

Conducting interviews

Twenty-two interviews were conducted in English and were telephonic or in-person. Most participants (20 of 22) granted permission to be audio recorded. Detailed notes were taken for the two participants who elected to not be recorded. Interview length averaged 52 minutes, with a range of 20 to 120 minutes.

Participants were provided a description of the study and consent form via email or in-person and asked if any further clarification was needed before beginning the interview. The interview guide (Appendix C) shaped the discussion. Participants were also encouraged to discuss any additional relevant topics that were critical to understanding the AT sector and how to increase access in Southern Africa. Subsets of questions within the interview guide were specific to the profile of participant groups (e.g., manufacturers). I also took field notes of possible themes and/or key insights after the interview that informed the coding and analysis process.

Participant data

As shown in Table 2.1 most participants were female (13), had AT experience in more than one Southern African country (12), and all but one resided in either Zimbabwe or South Africa at the time of the study. Participants' AT current positions were within public (5), non-profit (7) and for-profit sectors (10). Non-profit representatives were from international or national non-governmental organizations (NGOs). National NGOs included disability persons organizations (DPOs) and NGOs that are associated with international NGOs but operate independently like Leonard Cheshire organizations (http://www.leonardcheshire.org.zw/).

The primary role for most participants (15) was 'direct service', meaning that they were providing AT and AT-related services to end users as rehabilitation professionals or AT specialists. The remaining 7 participants served primarily in a leadership role as non-profit director/managers, for-profit business owners or public officials. Most participants served in multiple AT-related roles within their current positions such as advocacy, research, policy making and training for improving and increasing AT supply and access. The two primary roles of direct service and leadership were selected to distinguish between participants with mostly on-the-ground experience versus those that mainly operated at a higher level such as running a business or designing and implementing AT policies and programs. In practice, most participants fulfilled some aspects in both direct service and leadership roles over their career, so the 'primary' role was identified based on their current position.

Participants worked with a wide range of AT types and as expected mobility AT dominated with 17 of 22 of participants having experience with a range of mobility devices. The next most commonly reported AT type was 'aids for daily living' (11), and those mentioned least often included AT for 'environmental adaptations' (4) and 'communication' (3).

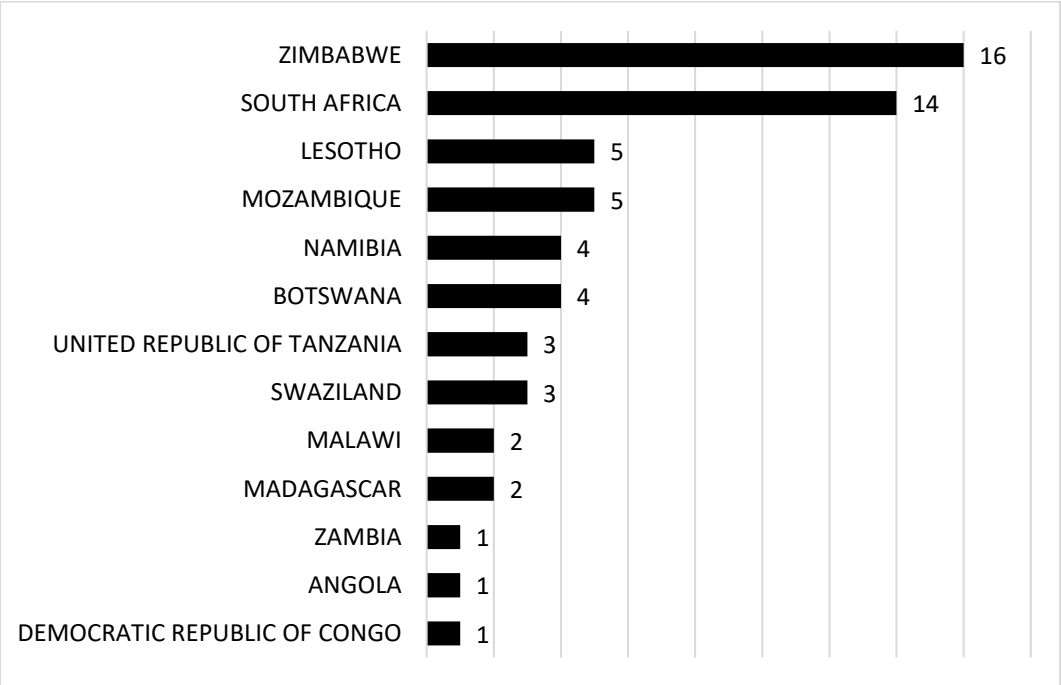
Table 2.1 Participant characteristics

	N
Total N	22
Gender	
Female	13
Male	9
Currently residing	
South Africa	11
Zimbabwe	10
Botswana	1
Primary role of current position	
Leadership (design, implementation or management of AT businesses, programs or policies)	7
Direct service to end users (e.g., OT, PT, AT specialist)	15
Sector and organization type	
For-profit/industry	10
Manufacturer	4
Supplier/provider	6
Government	5
Non-profit	7
International NGOs	3
Local NGOs (regional, national, community)	4
AT experience	
AT type*	
Mobility (wheelchairs, crutches, walkers, standing frames, seating, prosthetics, orthotics)	17
Hearing (hearing aids)	5
Vision (spectacles, blind and low vision ICTs)	5
Aids for daily living (toileting, bathing, household tasks)	11
Communication	3
Environmental adaptations	4
Other (alternative input, skin protection, learning)	4
With AT experience across Southern Africa**	12
Years of AT experience - Ave/SD	14.9/9.5

*Participants selected all that apply
**Participants have AT experience in more than one country in Southern Africa

Over half (12) had professional AT experience in more than one country in the Southern Africa. As shown in Chart 2.1, most participants have worked in Zimbabwe and South Africa.

Chart 2.1 Number of participants with AT experience in each Southern African country (N=22)



2) Documentation review

Four types of secondary data were compiled and analysed (Table 2.2). Most relevant documentation (digital or print) emerged from topics mentioned or specific resources identified by interview participants. For example, after several participants discussed the Motor Vehicle Accident Fund as a funder of AT in at least a few countries in Southern Africa, I conducted a Google search to identify which countries had an MVA and reviewed site for AT related information. Content gaps identified in documents compiled were filled by seeking out specific resources through existing contacts or online searching. A substantial time investment was made searching for AT coverage data through government websites that would capture AT types provided and budgets. Yet, this process yielded only piecemeal data from a few countries who had tendering awards posted for select ministries. The challenge of locating AT budget information within each country and the region highlighted the need for developing AT information systems to gauge AT coverage levels.

Documentation identified was organized into folders for each country, regional and international, and coded within the major topic areas. Most secondary sources identified applied to the policies building block within the AT system.

Table 2.2 Types of documentation

Documentation	Description
International	Descriptions of international AT initiatives, AT laws and policies (e.g., WHO guidelines), international NGO resources and international professional association's resources.
National	National AT-related policies, public tender documents, non-profit AT advocacy documents, Living Conditions Study reports.
Manufacturers and suppliers	Product catalogues and website information of industry suppliers/manufacturers (e.g., About Us, Services)
AT-Info-Map project	Data and information available on project websites (blogs, presentations, project summaries, database records and awareness resources) (Box 2.1)

Background on the AT-Info-Map project

I initiated the grant application for the AT-Info-Map project with collaborating partners after beginning doctoral study in 2014. Once the project was funded and launched in 2016, I served on both the leadership and implementations teams for the duration of the three-year project. The networks established through this parallel project helped in recruiting interview participants. Publicly available information and data generated by this project were included in the qualitative sub-study.

Box 2.1 AT-Info-Map project description

The Assistive Technology Information Mapping project (AT-Info-Map) was funded by the Google Impact Challenge for 3-years (2016-19). The AT-Info-Map project served to map the availability of AT in 10 countries in Southern Africa. The goals of conducting this mapping exercise were to inform end users and other buyers of where to find available AT and to capture gaps in supply. The Southern Africa Federation of the Disabled (SAFOD), AfriNEAD: Stellenbosch University, University of Washington (UW) and Dimagi were the four partners funded to develop and implement the AT-Info-Map project.

The AT-Info-Map project was piloted in Botswana in YR1 (2016-17) and then scaled up into nine other Southern African countries in YR2-3 (2017-19) including Angola, Zambia, Mozambique, Malawi, Zimbabwe, Lesotho, Swaziland, South Africa and Namibia. Mapping involved locating AT suppliers/providers (i.e., physical addresses) and identifying which categories of AT each provided. Identifying suppliers/providers was mainly achieved through word-of-mouth field work within each country as most this information was not available online or through other documented sources. Mapped records are publicly available through a mobile app (http://atinfomap.org/app.html) and website (https://assistivetechmap.org/).

Inclusion criteria for this information system were that the supplier/provider be legally registered in one of the 10 countries and provide some type of AT. Therefore, it did not screen out redundant intermediaries or inappropriate products or services. Adding stricter criteria for inclusion that required verifying these data was resource-intensive was not feasible within the funding limits and timeframe of the project.

Two major activities were added to the project design based on feedback from stakeholders (e.g., end users, representatives from for-profit AT suppliers, government and NGOs), specifically:

- Regional AT awareness raising was identified as essential to the overall project success.
- A broad range of disability services were added to the information system as these organizations were often the part of the pathway to learning about and accessing AT.

Awareness raising activities continued after the Google funding ended in early 2019 and the lead organization, SAFOD, is now planning a regional AT expo in Namibia (https://www.saate.org/). A snapshot of AT-Info-Map data and mapping features are presented in Appendix D.

3) Observations

I made observations during interviews and select activities associated with the AT-Info-Map project. Field notes were taken during observations that captured the activities observed and my interpretation of observations (meanings, insights and possible contradictions with other data sources). Examples of activities included:

- An interview conducted that included a tour of an AT manufacturing centre.
- AT product demonstrations made by interview participant during an interview.
- Observations made during an AT side-event at a Regional Disability Round Table in Johannesburg. During this event, I presented on the progress of the AT-Info-Map project and gathered feedback from the audience about ways to improve the project and increase AT access in Southern Africa (Southern Africa Federation of the Disabled 2017).

Data management

Data collected from all three sources were kept well-organized throughout the research process to ensure all data were used and accurately coded. Excel was used to track data collected and common naming conventions were applied to identify data source, file location, date and other pertinent information. Interview data and field notes that included personal identifiers were saved in secure location to ensure confidentiality (i.e., password protected Google drive).

Analysis

Interview audio recordings and transcripts, secondary data from the documentation review (Table 2.2) and field notes were included in the analysis. Interview data comprised the majority of data analysed for the qualitative sub-study. For the 20 of 22 interviews that were audio recorded, interview data were transcribed within NVivo by linking transcription segments to time slots of the audio recording. Interview data were categorized by interview questions and participants characteristics were classified. Data pertaining to the sub unit of analysis (role of interview participant, country) were examined separately as well as part of the overall data to identify diverging evidence.

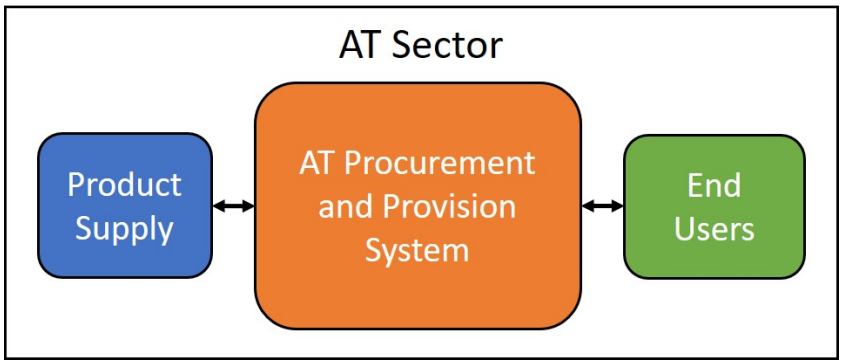
Potential codes were identified iteratively throughout the research process by identifying common topics and themes that arose during interviews and within other data sources. Once all data was collected and uploading into NVivo, codes were developed inductively to ensure comprehensive coverage of all possible topics, and deductively by applying the concepts within the conceptual framework of the AT system (see Section 1.3) (Yin 2014).

The primary strategy for inductive coding was through analytic memos I drafted following each interview. These memos listed and described major topics in bulleted form in 2-4 pages. Major topics (formatted as headers) were then uploaded and auto-coded within NVivo as potential codes. Similar codes were then combined, organized into major and minor topics, and compared with key themes within the original framework (e.g., financing). Multiple drafts of the coding structure were reviewed by my supervisor and revised based on feedback. The final codes were then applied to all data, often selecting multiple codes for each content segment.

Making sense of the coded data began by arranging the codes within the original AT system framework (i.e., building blocks, dimensions of AT access and levels of system), while keeping the core guiding research question in mind. Groups of coded data did correspond with many of the concepts within the original AT systems framework. Yet AT 'product supply' emerged as a broad, significant and distinct component instead of one of the six building blocks within the AT system as originally conceptualized. The product supply component encompasses characteristics of products, where and how products were sourced and supply chain dynamics. This component proved to be important in understanding the complex phenomenon of AT access.

The organization of three main interrelated components that comprised the AT sector included: 1) product supply, 2) AT procurement and provision system and 3) end users (Figure 2.2). This simple framework served as the starting point for making sense of the findings that were then interpreted and synthesized into more complex conceptual models.

Figure 2.2 Three components of the AT sector



Chapters 5 and 6 present the findings, covering topics and subtopics that were directly synthesized from the data (e.g., coded transcripts). Within each of the three components in Figure 2.2 the major themes served as the outline (sections) where coded topics and subtopics were described. For the central and most complex component, the AT procurement and provision system, the themes closely corresponded with the building blocks presented within the original AT system framework. Writing samples of topics and subtopics were reviewed by my supervisor to ensure the level of detail and use of quotes was appropriate. Throughout the writing process, possible key arguments to address the core research questions were noted.

To capture the relationships between topics and subtopics within the findings, namely barriers and facilitators to AT access, causal maps were created with NVivo mapping tools to visually represent underlying factors that resulted in key characteristics. A total of seven causal maps were created that served to synthesize findings within the two components (product supply and end users) and the five building blocks that comprised the AT procurement and provision system. The causal maps at the end of each section came from the data and served as a fruitful process for identifying patterns that were presented in the Discussion (Chapter 7). Causal maps are the original work of the author.

In Chapter 7, I interpreted the findings presented in Chapters 5 and 6. In an effort to develop a theoretical model to address the core research question, what works to access to assistive technology in Southern Africa? common patterns were identified across causal maps. Given that causal maps identified constraints that limited supply and access, pervasive bottlenecks across diagrams were identified before approaches to remedy these bottlenecks were developed. Identifying recommendations to respond to the primary bottlenecks in the AT sector was an iterative process in consultation with my supervisor. The aim of this consultation was to ensure that my interpretation was consistent with research data, not overly simplistic and yielded concrete recommendations to increase AT access to address the needs of end users within Southern Africa.

Empirical evidence that could demonstrate what works to increase AT access across Southern Africa is not yet available. The recommendations generated were labelled as strategic levers. These levers were informed by the study evidence and my opinion.

2.5 ETHICS

Ethics approval was received from the Human Research Ethics Committee at UCT for the secondary analysis of national survey data (836/2015) and the qualitative study (329/2017). The scoping review did not require ethics review because data sources came from existing research publications.

The secondary analysis of a subset of data from two national Living Conditions Studies (LCS) qualified for an expedited ethics review because the methods were limited to the analysis of existing data and did not involve further engagement of human subjects (research participants). I received de-identified LCS data sets to ensure the privacy of survey participants. Specifically, names, contact information and unique identifiers (ID #), were removed. In addition, the original survey data collected in the Living Conditions Studies received ethics review and approval from the Norwegian Social Science Data Services and relevant officials within both countries (Botswana and Swaziland).

The qualitative study underwent ethics review by the Human Research Ethics Committee (HREC) to ensure that all research activities were in compliance with UCT ethics policies. An expedited review was conducted based on the following criteria.

- Research activities that present no more than minimal risk to human participants, and involved only procedures listed in one or more of the following categories:
    - Research involving materials (data, documents) that have been collected or will be collected solely for non-research purposes, specifically for the AT-Info-Map project.
    - Collection of data from voice, video, digital, or image recordings made for research purposes.
    - Research that employs survey, interview, focus group, programme evaluation.

The study design and protocol outlined below, along with consent forms and data collection tools, were approved by the HREC.

A minimum of 20 participants would be invited to participate in interviews through purposeful and snowball sampling, starting with the AT-Info-Map network contacts. The following protocols were applied to ensure all qualitative research activities adhered to three ethical principles; 1) protecting study participants from harm, 2) protecting the privacy and confidentiality of study participants and 3) selecting study participants equitably. Study protocols included:

- Clear communication of study aims, process and uses of data to all research participants.
- Securing informed consent from all research participants.
- Confidentiality and security of research participant information and data.
- Implementing all study activities in a way that is sensitive to social and cultural norms.
- Purposely and snowball sampling to select study participants that represent the range of key stakeholder groups and diversity of viewpoints.

Before engaging in the study participants were clearly informed that they were free to stop participating in the study at any time (see Consent Form Appendix C).

One anticipated risk was that some participants may not disclose sensitive information about AT access such as negative experiences with international donors or lack of government funding, believing that this could compromise their political relationships or existing supports (i.e., financial). This concern was treated carefully throughout the research process and in writing this thesis, both by ensuring confidentiality of participant data and anonymity of any findings that could negatively affect study participants.

CHAPTER 3 ASSISTIVE TECHNOLOGY IN RESOURCE-LIMITED ENVIRONMENTS: A SCOPING REVIEW

[published article: Rebecca Matter, Mark Harniss, Tone Oderud, Johan Borg & Arne H. Eide (2016): Assistive technology in resource-limited environments: a scoping review, Disability and Rehabilitation: Assistive Technology, DOI: 10.1080/17483107.2016.1188170]

3.1 INTRODUCTION

Access to appropriate assistive technology (AT) is a challenge across the globe, but people living in low- and middle-income countries (LMICs) face additional challenges. The Community Based Rehabilitation (CBR) Guidelines Health component (WHO 2010) indicates that in many low-income countries, only 5-15% of people who require assistive devices and technologies have access to them, availability is often low, there are few trained personnel, and costs may be prohibitive. Recent studies on living condition among people with disabilities in southern African countries document that only 15-25% of people with disabilities who need AT have access to it (Eide and Øderud 2009).

A conservative calculation of the number of people with disabilities who might benefit from access to AT in LMICs based on WHO estimates of global disability[2] [3] [4] [5] and total population of 6.1 billion[6] in LMICs of is 650 million people. While this is an underestimate of demand because it does not include all types of AT (e.g., learning, cognition, communication, daily living devices) and does not account for people who use more than one device at a time, it still serves to demonstrate the magnitude of need.

Estimates of the total number of people who require AT in LMICs must also account for the increase in disability-related chronic conditions and aging populations. The Burden of Disease Study (2010) reports that the changing global demographics of disease are shifting away from infectious disease and towards noncommunicable diseases and disorders, such as musculoskeletal conditions, stroke, and diabetes, which are associated with disabilities (Murray, Vos et al. 2012, Woolf, Erwin et al. 2012). Improvements in trauma care are another global health trend that are likely to result in an

[2] 5% of global population have hearing loss (WHO), http://www.who.int/mediacentre/factsheets/fs300/en/
[3] 285 million people are estimated to be visually impaired worldwide (90% reside in developing countries (WHO), http://www.who.int/mediacentre/factsheets/fs282/en/
[4] 1% of population in developing countries in need of wheelchairs (WHO, 2011)
[5] .5% of population in developing countries are in need of orthoses or prosthetics (WHO, 2011)
[6] The total population for 'less developed regions' (6.1 billion) came from the 2015 estimates reported by the United Nations, Department of Economic and Social Affairs, Population Division, http://www.un.org/en/development/desa/population/

increased need for AT. Trauma caused by injury and violence, a leading cause of disability and death in LMICs (Soomro and Jalal 2013, WHO 2014), often results in people living with short or long-term disabilities who would benefit from AT.

The most comprehensive literature review to-date of peer-reviewed research publications on AT in LMICs found that "there is a general lack of evidence to support effective implementation of the required AT measures of the CRPD (UN Convention on the Rights of Persons with Disabilities)" ((Borg, Lindstrom et al. 2011), p.24). This literature review applied a search and selection criteria that yielded a total of 52 articles published between 1995 and 2009. Borg et al. found that available research was primarily product-oriented and addressed limited types of AT (i.e., leg prostheses and wheelchairs); sparse in addressing system level issues such as service delivery to ensure AT is available and affordable, and failed to address a broad range of AT types such as sensory and cognitive aids.

In light of the paucity of research on AT within LMICs and other resource limited environments, the development of international guidelines and standard setting documents that address AT such as the World Report on Disability (WHO and World Bank 2011), CBR Guidelines (WHO 2010), Wheelchair Guidelines (WHO 2008), and the Joint Position Paper on the Provision of Mobility Devices in Less Resourced Settings (WHO 2011) rely on studies from high income countries, a few studies from less resourced settings (e.g., the SINTEF Living Conditions Studies) and expert opinion.

The unmet and growing need for AT within LMICs, coupled with the lack of research available to inform policy and practice, motivated this scoping review. We conducted a scoping review of existing AT literature from resource limited environments (RLEs) in order to identify and characterize the evidence available, and describe the anticipated challenges and complexities of conducting further systematic reviews and other research in this nascent field. RLEs are common in LMICs but can also be found in high-income countries. This scoping review expanded upon the search strategy applied in the earlier literature review (Borg, Lindstrom et al. 2011) in order to comprehensively map the AT research landscape in RLEs.

Scoping review

The majority of this scoping review was conducted as part of a larger evidence review process commissioned by the World Health Organization (WHO) to inform the development of Guidelines on Health-Related Rehabilitation (WHO 2012a), and was guided by an international expert panel and the WHO Handbook for Guideline Development (WHO 2012b). Additional analyses were conducted after the completion of the WHO project for this article.

A scoping review is carried out to develop an understanding of the research landscape by examining the extent, range and nature of existing evidence (Grant and Booth 2009). Scoping studies typically involve 5 steps: (a) identify the research questions, (b) access all pertinent studies, (c) determine which studies to keep for detailed analysis, (d) chart the data iteratively according to criteria established by the authors, and (e) organize and summarize the findings (McColl, Shortt et al. 2009). Scoping reviews focus on comprehensive coverage regardless of the type of evidence, which allowed us to identify strengths and weaknesses in the literature base. Scoping reviews generally do not engage in grading or assessing the quality of evidence but are ideal for clarifying complex concepts and refining questions to support future systematic reviews.

In our project, the scoping review allowed us to provide an overview of key topics, identify gaps in evidence, clarify complex concepts, and refine approaches and questions that would be most appropriate for future systematic reviews. In the scoping review we were broadly inclusive (i.e., if there was a doubt about whether a publication should be included or not, we included it). In the following sections, we describe our scoping review methods and results.

3.2 METHODS

A development plan was drafted and refined based on feedback from members of the expert panel, and used to set the parameters for searching, screening, extraction, and analysis. The four components defined in the development plan included review questions and goals, study population, inclusion & exclusion criteria, and key literature search terms and sources.

Research question

Our search was designed to address the following broad level question: *What evidence is available on assistive technology (AT) in resource limited environments (RLEs)?*

Population of focus

The population of focus for the review was persons with disabilities in RLEs. Disability is a complex and evolving concept that is not used consistently in the literature or across cultural contexts. For the purposes of this review, we chose not to define disability to allow for authors' different concepts of disability. We did, however, include all types of impairments even if the term 'disability' was not used. Impairments are defined as problems in the body function or alterations in the body structure (WHO 2013). WHO has defined an RLE as "a geographical area with limited financial, human and infrastructural resources to provide rehabilitation (a common situation in low- and middle-income countries, but also in certain areas of high-income countries)" (WHO 2012a).

Inclusion and exclusion criteria

Inclusion and exclusion criteria were defined within the development plan to guide the search strategy. Each set of criteria consisted of the following parameters.

Inclusion criteria

- Studies that addressed a combination of key concepts defined to capture evidence about assistive technology in low resourced settings (see following section on Search Concepts).
    - We conceptualized AT broadly as "Any item, piece of equipment or product system, whether acquired commercially, off-the-shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (United States Congress 2004). This inclusive definition is also used in the World Report on Disability (WHO and World Bank 2011). Articles did not need to use the term "assistive technology" in order to be included. Rather, we used specific search terms for a broad range of assistive devices.
- Literature was searched from 2000 through 2013.
    - The year 2000 was identified because the 2000 NGO summit on disability was held in Beijing during which the call was made for a human rights convention on disability. It is likely that the call and the ongoing work toward the Convention on the Rights of Persons with Disabilities spurred research in this area.
- Non-English studies were included in the search strategy as long as an English abstract was available.
- Studies were not limited by age, disability, or impairment type.
- Types of research included quantitative, qualitative and mixed method studies; both intervention and descriptive studies.
- Document types included journal articles, book chapters, technical reports, and policy reviews.

Exclusion criteria

- Theoretical, testing of measures, historical reviews, patents, prevalence studies.
- Editorials/commentaries, lectures/speeches, abstracts, bibliographies, book reviews.
- There were also a number of topic areas that were excluded based on guidance provided from WHO and the expert panel such as:
    - Vocational training/rehabilitation
    - Endoprosthesis (e.g., arthroplasty/joint prosthesis, ligament prosthesis)
    - Implants (e.g., cochlear, pacemakers)

- Orthopaedic diagnostic devices
- Orthopaedic fixation devices (e.g., casts, nails)
- Medical devices used for diagnostic, monitoring, or therapeutic/surgical treatment purposes
- Sign language
- Lip-reading
- Non-disability related information and communication technologies (ICTs)

Search concepts

The following two search strategies of combined concepts of interest were conducted using Boolean-logic queries:

Table 3.1 CONCEPT A (assistive technology) 'AND' CONCEPT B (resource limited environment)

OR

Table 3.2 CONCEPT C (disability) 'AND' CONCEPT D (broad AT terms) 'AND' CONCEPT B (resource limited environment)

Search terms were identified through thesauri-based expansion within each of the academic databases, feedback from the expert panel, and expert consultation provided by a University of Washington Health Science librarian to ensure the highest and most relevant yield of articles.

Table 3.1 Search strategy A

CONCEPT A: Assistive technology	**CONCEPT B: Resource limited environment**
Example terms: self-help devices, assistive technology devices/equipment/aids, assistive technology services	Example terms: Developing country/nation/region, low resourced, less resourced, low- and middle-income countries (World Bank Classification)

Table 3.2 Search strategy B

CONCEPT C: Disability	**CONCEPT D: Broad terms to capture AT**	**CONCEPT B: Resource limited environments**
Example terms: disabled persons, Persons/people with a disability, disabled, impairment	Example terms: equipment design, technology, equipment safety	Example terms: Developing country/nation/region, low resourced, less resourced, low- and middle-income countries (World Bank Classification)

Final search results from the two strategies above were then combined with excluded terms with 'NOT' (i.e., dental, cochlear implants). (See full search strings and detailed search results in Appendix A.)

The academic databases identified as primary sources were PubMed, CINAHL, EMBASE and Cochrane. These databases were selected because they were most likely to yield higher quality studies and had sophisticated search features that allowed for efficient, focused and replicable searches.

A total of 3081 publications were identified in the search. After 423 duplicate records were removed, 2658 publications were included in the review.

Table 3.3 Search results

Database	**Platform**	**Date range**	**Search date**	**Results**
PubMed	NCBI	1/1/2000-12/31/2013	12/4/2013	643
EMBASE	Elsevier	1/1/2000-12/31/2013	12/7/2013	1562
CINAHL Plus with Full Text	Ebsco	1/1/2000-12/31/2013	12/12/2013	773
Cochrane	John Wiley & Sons	1/1/2000-12/31/2013	12/12/2013	103
			Total	3081
			Duplicates	423
			Final results	2658

Screening

A broad level screening protocol was used to identify any potentially relevant evidence on AT in RLE. The abstract for each record (publication) was reviewed to ensure the following three criteria questions were addressed in addition to the inclusion/exclusion criteria noted above.

1. Does the publication address AT as a primary research topic?
2. Does the publication focus on a resource limited setting or resource limited population?
3. Does the publication provide research evidence?

Two independent reviewers screened the abstracts of the first 100 records and compared results in order to refine coding categories and process and address common discrepancies in coding (see Appendix A for inclusion/exclusion coding scheme).

One reviewer screened the abstracts of the remaining records. If the reviewer was uncertain about whether or not to include a record, it was included for further review during round one screening and extraction process.

Calibration and inter-rater agreement

A sample of approximately 10% (296 records) of the 2658 records from the initial search were screened by a second reviewer (first 10 records of each set of 100) to reduce risk of bias. Exclusion and inclusion decisions were compared on the 10% sub-sample to assess inter-rater agreement. Discrepancies in coding were resolved through consensus by the two reviewers.

Out of 296 items coded, there was 94.9% agreement. Cohen's Kappa was calculated at .785. Cohen's kappa is a measure of the agreement between two raters. Kappas over 0.75 are considered excellent (Fleiss 1981). Each of the 15 disagreements were discussed and resolved through negotiation.

Table 3.4 Inter-rater agreement

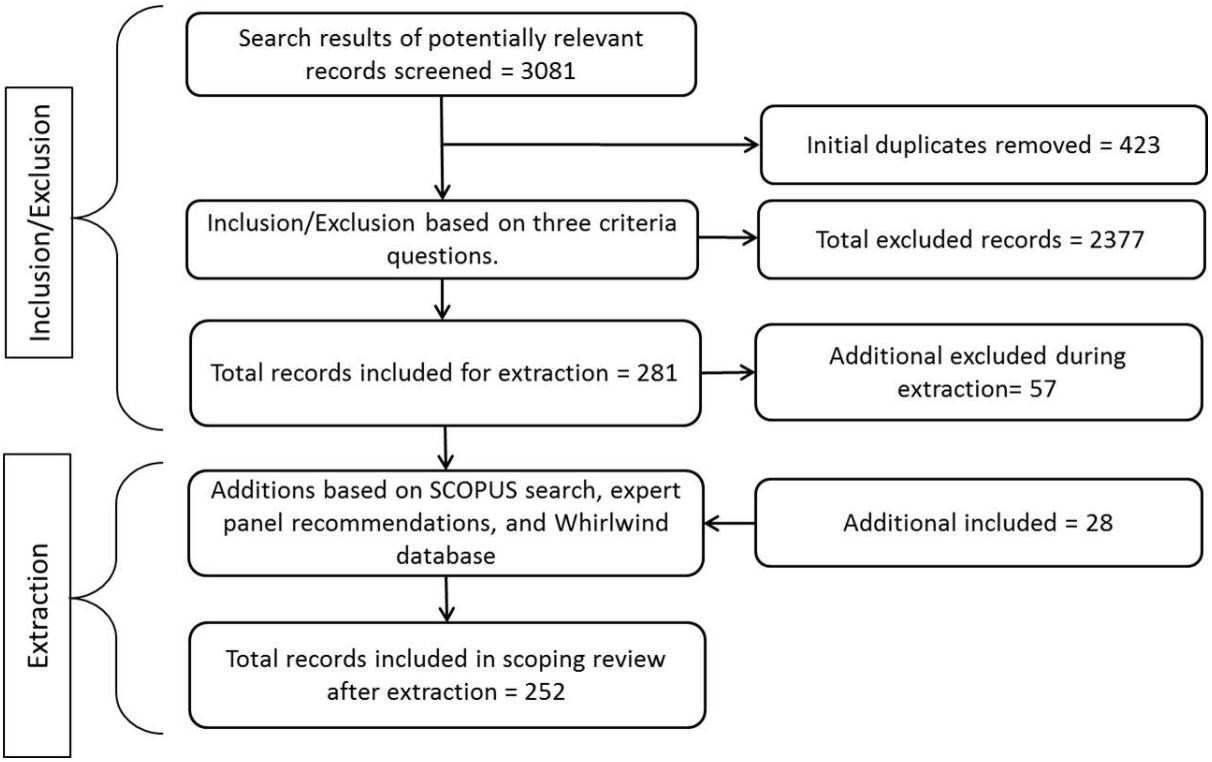
N Agreements	N Disagreements	Percent Agreement	Cohen's Kappa
281	15	94.9%	0.785

Additional evidence added and removed

After the initial screening, we considered the inclusion of additional publications from three sources: (a) publications included in a database provided to us by Whirlwind's Assistive Technology Research Division from a review they conducted in 2010-11, (b) SCOPUS searches conducted using high quality RCTs and systematic reviews identified in the first round, and (c) recommendations from our expert panel.

During the extraction process (described in the next section), 57 records were excluded based on further review, resulting in 224 publications. We then added 28 unique records based on follow up SCOPUS searches and additional materials from our expert panel to yield a total of 252 included publications. The flowchart in Figure 3.1 graphically depicts the process. See references for all 252 publications in Appendix A.

Figure 3.1 Screening flowchart



Data extraction

Data extraction was conducted by one reviewer for all included records, and 10% of records were extracted by a second reviewer to ensure reliability. In order to gain a broader understanding of the breadth of research available, we extracted the following types of information:

- Year
- Region (based on World Bank classification - http://data.worldbank.org/about/country-and-lending-groups.)
- Countries in which research was conducted
- Study design
- Sample size
- Types of AT

Information was extracted using REDCap electronic data capture tools hosted at the University of Washington. REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies.

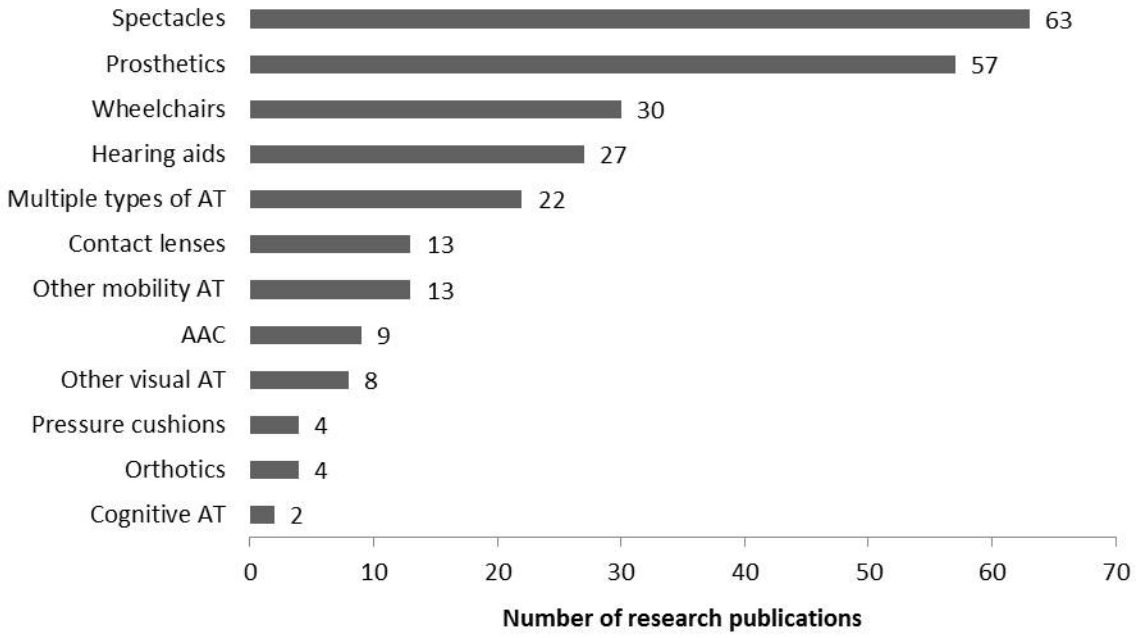
The goals of the rapid extraction process were to provide a descriptive numerical summary (e.g. number of studies included by year, sample, region, topic, etc.), and to begin developing a method for classifying and defining assistive technology research.

3.3 RESULTS

Type of assistive technology

Each record was coded for one primary type of AT. The primary types of AT most frequently addressed in research publications were spectacles (eye glasses) and prosthetics. These categories comprised nearly 50% of all included publications.

Figure 3.2 Number of publications by AT type



Description of select AT types:

- Multiple types of AT – publications addressed more than one primary type of AT or addressed the concept of AT broadly, not identifying specific types.
- Other mobility AT – Devices other than the wheelchairs used for mobility such as walking canes, walking frames, scooters, or computer input device for limited hand mobility.
- Other visual AT – Visual technologies other than glasses and contact lenses such as magnifiers or screen readers.

Assistive technology by domain

The AT types were grouped into five domains to capture the activity limitations that are addressed by different types of AT (Table 3.5). Eleven of the 22 publications identified as addressing Multiple Types of AT in Figure 3.3 were coded into one of the five domains (e.g., an article on prosthetics and

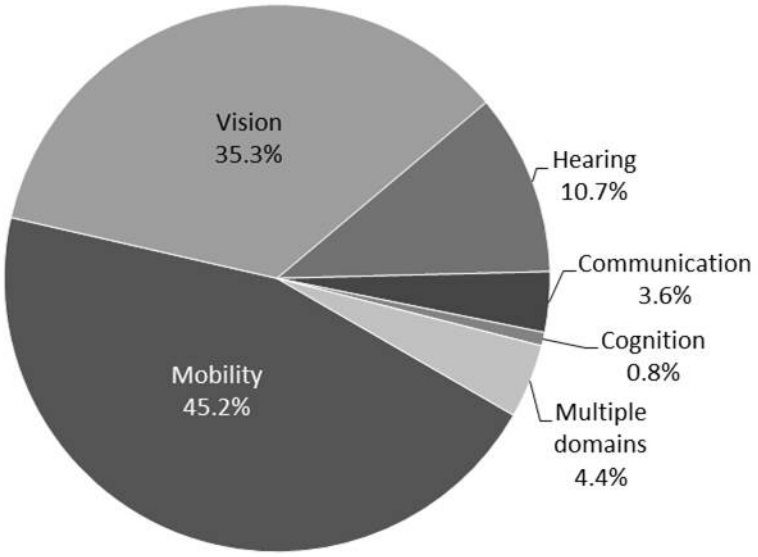
orthotics was coded as Mobility). The 11 remaining publications addressed more than one primary domain and were consequently coded in more than one domain.

Table 3.5 Grouping of AT by domain

Domain	**AT type**	**n**
Mobility	Prosthetics Wheelchairs Other mobility AT Orthotics Pressure cushions	114
Vision	Spectacles Contact lenses Other visual AT	89
Hearing	Hearing aids	27
Communication	AAC	9
Cognition	Cognitive AT	2
Multiple domains	Article addressed more than one primary activity domain	11

When publications are grouped by domain, mobility has the highest number of publications (45.2%), followed closely by vision (35.3%) (See Figure 3.3). AT products that address cognition comprise less than 1% of the publications.

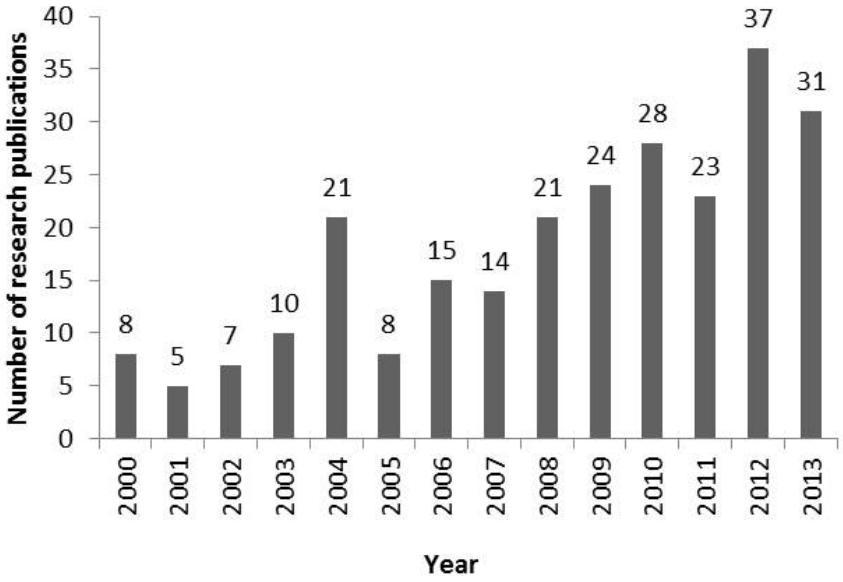
Figure 3.3 Percentage of publications by activity domain



Publication year

The number of articles being published in this field has generally been increasing in the years from 2000-2013 with a low of 5 publications in 2001 to a high of 37 publications in 2012 (See Figure 3.4). However, the numbers are still relatively small with an average of 19 publications per year over the 13-year period.

Figure 3.4 Number of publications by publication year (2000–2013)

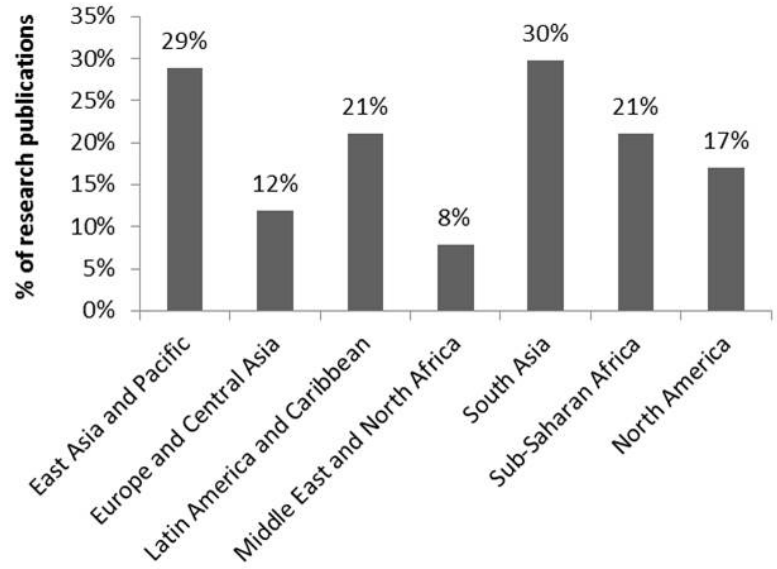


Region

Each record was coded for one or more regions[7] to capture the locations where the research studies took place. Percentages in Figure 3.5 are the percentage of total records (252 records). Research is not evenly spread across regional areas, with the largest number conducted in South Asia (primarily India), and East Asia and Pacific (primarily China). The fewest number of studies have been conducted in the Middle East and North Africa. The top five countries where research studies were conducted are India, China, Brazil, South Africa, and the United States.

[7] See countries listed within each of the seven World Bank regions here: http://data.worldbank.org/about/country-and-lending-groups

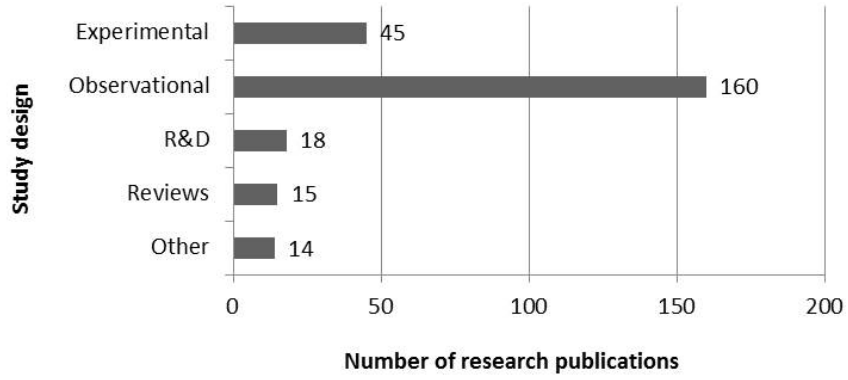
Figure 3.5 Percentage of publications by region



Study designs

Figure 3.6 shows the number of pubications by study design. The research design used in a study is an indicator of the strength of evidence potentially available. Over 63% of the research studies captured in our scoping review were observational studies (N=159). These included noncomparative, cross-sectional, prospective or retrospective cohort, and before-after designs. Experimental studies were the second most common, comprising nearly 18% (N=45) of all publications. These included RCTs, nonrandomized comparative, case-control, cross-over trial, controlled before-after, and repeated measures designs. Only 9 of the 45 experimental studies were randomized, controlled trials, which are considered the gold standard of evidence. The rest of the publications fell into the categories of R & D studies (i.e., research and product development studies, prototype testing), Reviews (i.e., systematic, scoping, literature reviews), and Other (i.e., mathematical simulation, cost-effectiveness, validation of standards/measures).

Figure 3.6 Number of publications by study design



Sample size

Of the 252 records, 213 reported a sample size. The remaining 39 records did not have the sample size available either due to the types of study (e.g., description of R & D process, systematic review) or abstract was unclear or full article was not available. Table 3.6 shows descriptive statistics for sample size. A few very large studies skew the mean as can be seen by the mean sample size of 5,733 compared to the median of 99.

Table 3.6 Sample size summary (n=213)

Mean		5753.33
Median		99.00
Std. Deviation		30684.59
Minimum		1
Maximum		372174
Percentiles	25	27.00
	50	99.00
	75	551.50

As shown in Table 3.7, the average sample size varied widely across AT categories with contact lenses and multiple types of AT having the largest sample sizes on average.

Table 3.7 Sample size summary by AT category

	n	Mean	Median	Standard Deviation	Minimum	Maximum
Contact lenses	13	48476	2270	53968	20	112900
Multiple types of AT	22	22257	293	90172	6	372174
Spectacles	63	2923	684	4438	8	17734
Hearing aids	27	1519	71	6466	10	31842
Other visual AT	8	127	134	42	80	201
Wheelchairs	30	126	24	297	8	1350
Prosthetics	57	124	35	210	1	885
ACC	9	87	34	151	8	480
Pressure cushions	4	40	29	41	3	99
Orthotics	4	34	50	29	1	51
Cognitive AT	2	1	1	.	1	1

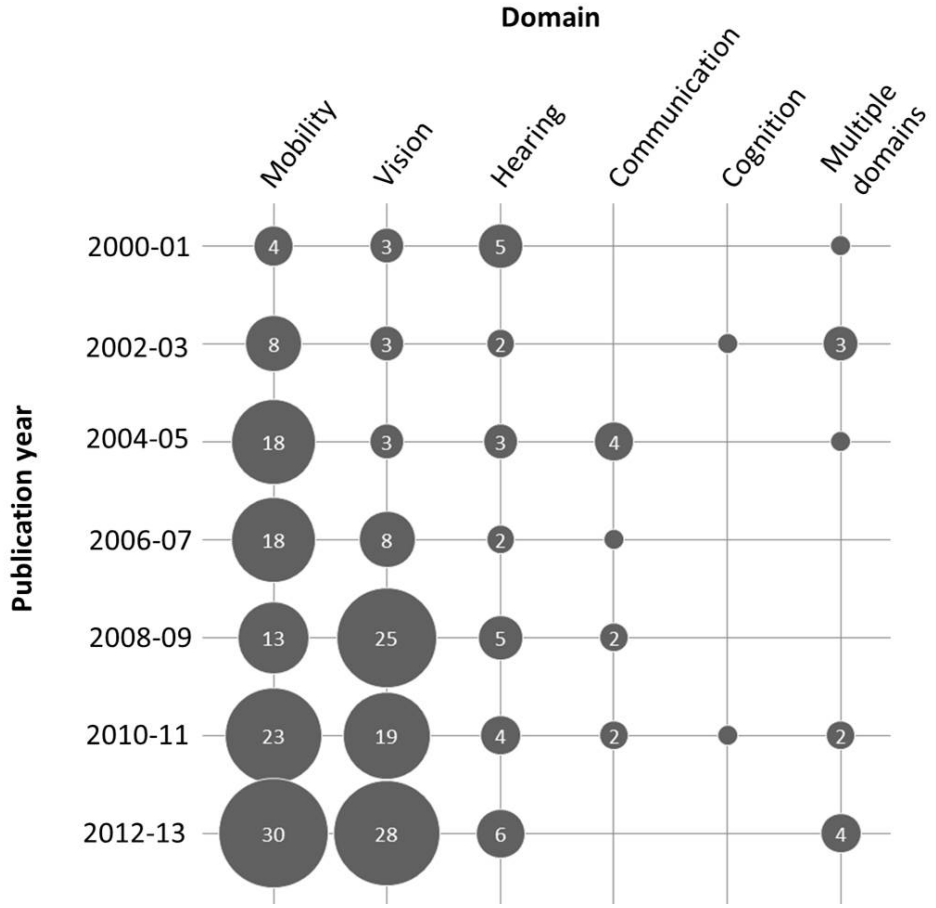
Domain explorations

We engaged in a deeper exploration of our findings by creating bubble charts to display the domain and numerical data along with one other relevant variable. In the following sections, we highlight domain by year, region, and study design. The size of the bubble in each chart is proportional to the number of publications within each X and Y category.

Domain by year

Figure 3.7 shows that research on mobility has generally increased over time and has overwhelmed research on any other domains in all but one year. In contrast, for vision, there is a jump in the number of publications on AT starting in 2008, with less than 20% (17 out of the total 89) published between 2000 and 2007. Other domain categories where there were fewer publications total (hearing, communication, cognition) do not show an increase over time.

Figure 3.7 Domain by publication year



Domain by region

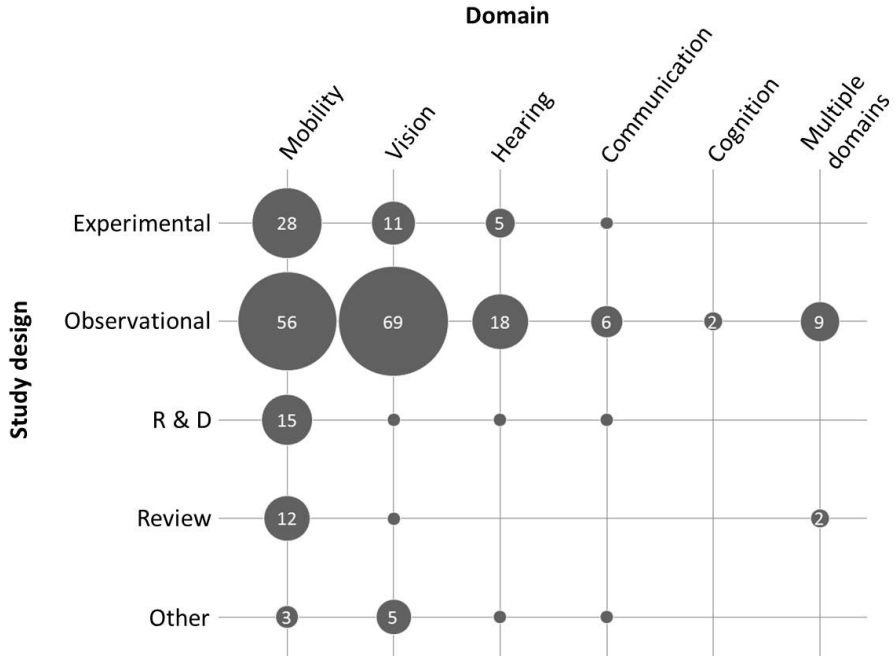
Figure 3.8 shows domains by regions. As expected, publications categorized within the domains of mobility and vision dominated across all regions. The number of publications that addressed the vision domain was greater than mobility in the majority of regions. However, Latin America and the Caribbean had over twice as many AT publications that addressed mobility in comparison to vision, and mobility also exceeded vision publications in North America. Note that records were coded by one or more regions so total quantity within each domain may be greater than total reported by domain in Table 3.5.

Figure 3.8 Domain by region

Domain by study design

Figure 3.9 shows the domain by study design. The majority of experimental studies were within the mobility domain, whereas the majority of observational studies were focused on the vision domain. Fifteen of the total 18 reviews (included systematic and literature reviews) covered mobility domain.

Figure 3.9 Domain by study design



3.4 DISCUSSION

Characteristics of AT evidence

We looked for research about assistive technology in resource limited environments and found a total of 252 publications. The quantity of research available is limited with an average of only 19 studies per year during the 13-year span of our scoping review. While our findings show that there has been a general increase in the number of studies being published between 2000 and 2013, this increase was only found in AT publications that addressed mobility or vision and not in the domains of hearing, communication or cognition (See Figure 3.7).

It is also clear that research is not evenly distributed across types of assistive technology or regions, and that these variations are not likely to be proportional to need. Some assistive technologies have significantly more research. In particular, spectacles (n=63) and prosthetics (n=57) have received the most attention followed by wheelchairs (n=30) and hearing aids (n=27). Some important areas of AT have very little research evidence such as augmentative and alternative communication (n=9), pressure cushions (n=4), orthotics (n=4) and cognitive AT (n=2).

Although we did not grade evidence for this review, it seems clear that there is limited high quality evidence among the total 252 included publications, with most of the research being observational (63%). Of the 45 experimental studies (18%), only nine of these studies were identified as randomized, controlled trials (RCTs). In addition, although there were 15 reviews (6%), only four used some metric to assess the quality of evidence.

Research recommendations

The research community and funding organizations have devoted inadequate attention and resources to increasing the knowledge base on AT within RLEs, both in terms of quality and quantity of research available. Lack of research funding for AT studies, competing priorities within the development and global health arena, and the feasibility of conducting rigorous studies on AT within RLEs may help explain the paucity of evidence available.

We make the following recommendations to advance this field of research:

1. Use evidence review methods that are appropriate for evidence base.

This scoping review on AT evidence in RLEs is the most comprehensive to-date, with 252 peer-reviewed studies identified. However, the evidence base has not yet matured in terms of the quality of research available to support Cochrane style systematic reviews of effectiveness. It is well documented that the gold standard of RCTs are often not feasible or the best model within the field

of rehabilitation due to small sample size, individualization and customization of treatment that is often required, challenges in allocation concealment and blinding, and the ethical concerns regarding control groups (Johnston 2009).

Given the volume of rich data available in observational research, evidence review methods should expand study-design selection criteria to include observational studies and apply suitable review and quality grading approaches (i.e., systematic review of qualitative research, meta-synthesis, realist reviews). A recommended approach that allows for a heterogeneity of study designs in one systematic review is to apply the Cochrane risk of bias tool (Higgins, Altman et al. 2011) for randomized and non-randomized quantitative studies, and the Critical Appraisal Skills Programme (CASP) (http://www.casp-uk.net/) for qualitative studies.

In order to determine the level of confidence (strength of evidence) of findings that results from the synthesis of evidence, the GRADE or CERQual tools can both be used.

- The Grading of Recommendations Assessment, Development and Evaluation approach (GRADE) (Guyatt, Oxman et al. 2011).
- Confidence in the Evidence from Reviews of Qualitative research (CERQual) (Lewin, Glenton et al. 2015).

These two tools, while distinct in specific criteria, will allow for synthesis of ratings because the scoring systems and criteria categories are comparable.

2. Use a common definition of 'assistive technology'.

The broad definition of AT that is used within the World Report on Disability, "Any item, piece of equipment or product system, whether acquired commercially, off-the-shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities", does not specify which product types are included or excluded. The ISO 9999:2011 Classification and Terminology (http://www.iso.org/iso/catalogue_detail.htm?csnumber=50982) provides greater detail on products to include and exclude such as the exclusion on implanted devices or non-technical solutions (e.g., personal assistance, guide dogs, lip reading). Authors recommend using ISO 9999:2011 definitions and terminology for AT and for specific product types such as prosthetics in future studies.

3. Develop a typology of AT research focus areas.

During the scoping review, we attempted to categorize research by study focus but found this to be challenging due to the diversity of study objectives and the absence of a typology to categorize AT research by study purpose. As a suggested way forward, we have built upon existing health systems

frameworks (Gilson, Hanson et al. 2011, Bigdeli, Peters et al. 2014) and the focus areas used by Borg et al. to draft a typology (Table 3.8). This draft typology aims to support the synthesis of existing evidence by focus area and identification of gaps in evidence. Testing and refinement of this typology is required to ensure that the categories, subcategories and example topics are clear, comprehensive and useful.

Table 3.8 AT research focus areas

AT research focus area		**Example topics**
Users	Needs	User expectations User abandonment Barriers to access User costs and willingness of pay Community, national and global level needs assessment Unmet needs Projections of need
	Outcomes	User satisfaction with products and services Participation outcomes Clinical outcomes Economic outcomes
Products	Design and performance	Product performance Product quality Compliance with design standards Materials used
	Production	Production/manufacturing methods Production/manufacturing costs
Service and product delivery	Services	Practice patterns Compliance with service standards Awareness and knowledge of service providers Training outcomes of service providers
	Product supply	Supply of products – distribution, delivery Supply of services – distribution, delivery Supply chain analysis Actors
Governance	Policies - procurement, licensing CRPD reporting Regulations Intellectual property rights and patents Enforcement systems - inspection Bureaucracy	
Human resources	Workforce needs and shortages Retention practices	
Financing	Financing models Pricing policies Affordability Cost benefit and cost effectiveness	
Information	Surveillance data Supply management Public awareness	

4. Strengthen platforms that promote the advancement of AT research in RLEs.

In recent years, momentum has been building in the field of global AT and there are now a few platforms (i.e., organizations, events, publications) that support the ongoing sharing of research and research expertise focused on AT within RLEs.

In 2014, the WHO launched the Global Cooperation on Assistive Health Technology (WHO-GATE) initiative to improve access to high-quality, affordable AT (WHO 2015). The WHO-GATE Research Working Group recently identified five priority research areas:

1. Evidence about effects, return on investment and economic impact of assistive technology.
2. Service delivery systems and models, including best practices and evaluation criteria.
3. Development of new, low-cost and high-quality technologies/devices.
4. Capacity development and training in the field of disability research and assistive technology.
5. Basic needs assessment at a community level, scoping the problem.

UNICEF in collaboration with WHO organized the Assistive Products for Children with Disabilities (APCD) Forum in July, 2015 in Copenhagen (www.unicef.org/supply/index_82298.html); and published a discussion paper, Assistive Technology for Children with Disabilities: Creating Opportunities for Education, Inclusion and Participation (WHO and UNICEF 2015).

Additional support is required to develop new global platforms and strengthen existing ones that serve to advance global AT research in resource limited environments - where 80% of global population of people with disabilities reside.

5. Increase funding for AT research within RLEs.

The lack of funding for AT research with RLEs is a major barrier to advancing this field of research and evidence-based practice. The CRPD requires that State Parties 'promote research and development' of AT (Article 4) and calls for international cooperation to help meet national obligations [24]. Leading international funders within the global health and development arena have the opportunity to spur rapid progress in addressing global AT needs.

All research focus areas identified above (Table 3.8) require substantial funding to conduct rigorous and large scale studies, systematic reviews, and high quality studies of all sizes on single or multiple AT domains. Funding is also needed to translate evidence to inform practice and policy, and for use by advocates and disability networks within resource limited communities who are working to increase AT access.

3.5 LIMITATIONS

A major limitation of this scoping review is that only four academic databases were systematically searched to identify potential publications for inclusion, thus publications from other sources were missed. While search strings were comprehensive and developed with input from the advisory panel, expanding the search sources to include grey literature, disability and rehabilitation databases (e.g., PEDRO, NARIC, The Source, AHMED) or regional databases (e.g., WHODB/WHOLIS) was beyond the scope of this project. The exclusion of some topics may pose a limitation as studies on vocational rehabilitation, patents, or testing of measures could include AT evidence. Other limitations are that only 10% of records were screened and extracted by second reviewer, and that publications without an English abstract were excluded. Finally, the original data searches were completed in December 2013 but funding was not available to update the results to include 2014-15 publications.

3.6 AUTHORS CONTRIBUTION TO PAPER

RM and MH conceptualized the research project, developed scoping review protocols, conducted analysis, and drafted the manuscript. RM conducted searches, screening, extraction, and analysis of all records. MH conducted screening and extraction on a subset of records to determine inter-rater reliability, and extracted study design for all records. Co-authors JB, TO, and AE provided expertise and guidance during all stages of scoping review, assisted in proposal development, and recruited expert panel members. Members of the expert panel played a central role in refining the development plan, specifically in identifying search sources, and inclusion/exclusion criteria, and in providing key research publications. All authors reviewed, edited and approved the article.

CHAPTER 4 SECONDARY ANALYSIS OF SURVEY DATA: ACCESS TO ASSISTIVE TECHNOLOGY IN TWO SOUTHERN AFRICAN COUNTRIES

[published article: Rebecca Matter & Arne H. Eide (2018): Access to assistive technology in two Southern African countries. BMC Health Services Research. Oct 19;18(1):792, DOI: 10.1186/s12913-018-3605-9.]

4.1 INTRODUCTION

Millions of people in Southern Africa are deprived of basic human rights such as the right to education and work because of the unmet demand for assistive technologies (AT) (Eide and Øderud 2009, Visagie, Eide et al. 2017). The World Report on Disability uses the following definition of AT; "Any item, piece of equipment or product system, whether acquired commercially, off-the-shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities"(WHO and World Bank 2011). A few examples of AT include prosthetics, hearing aids, spectacles, white canes and adaptive eating utensils. Increasing access to AT in Southern Africa requires more products and services – in terms of quantity, quality and variety – as well as the reduction of barriers to existing AT. To achieve these aims, a comprehensive understanding of demand and supply-side facilitators and barriers is critical. This study serves to identify the sociodemographic factors (demand-side) that are associated with AT access in two countries in Southern Africa, Botswana and Swaziland. This demand-side analysis of national survey data aims to increase our understanding of who is accessing and not accessing AT.

For this study, Southern Africa refers to the 15 countries that comprise the Southern African Development Community (SADC 2012). All member states in Southern Africa, with exception of Botswana, have signed the UN Convention on the Rights of Persons with Disabilities (CRPD), that explicitly addresses the provision of AT in numerous Articles (i.e., 4, 9, 20, 21, 24, 26, 29 and 32) (United Nations 2006). Researchers have also shown that access to AT is critical to achieving all of the 17 Sustainable Development Goals (Tebbutt, Brodmann et al. 2016). Yet achieving these rights and goals are out of reach when the AT sector in Southern Africa continues to be under funded, fragmented, and not well understood.

Researchers have begun to develop an inventory of demand-side factors that may determine access to AT in Southern Africa but have yet to prioritize these factors or determine their relationships to each other. Sociodemographic factors mentioned in a recent publication on AT provision and

outcomes in four Sub-Saharan Africa countries (South Africa, Namibia, Malawi and Sudan) included age, gender, poverty, location (rural vs. urban), and type of disability (Visagie, Eide et al. 2017). Existing evidence on AT in Southern Africa continues to be dominated by studies on mobility and vision devices, with few studies on hearing or communication related AT, and virtually no research on cognitive AT (Matter, Harniss et al. 2017). These studies generally focus on one country and one type of AT so fail to provide evidence about the AT sector as a whole in the Southern Africa region.

In this study, we posited that rurality may be the most important factor in explaining AT access in Southern Africa as the majority of AT providers are in urban centers, and rural residents face numerous barriers to accessing health care and other services in Southern Africa (Kiwanuka, Ekirapa et al. 2008, Lankowski, Siedner et al. 2014, McLaren, Ardington et al. 2014). Rural location has also been associated with lack of AT access in a few other Southern African studies (Ikeda, Grabowski et al. 2013, Bozzani, Griffiths et al. 2014, Ennion and Johannesson 2017). An alternative theory is that disability type (i.e., mobility impairments) is the most important factor as mobility devices are the most commonly available type of AT in Southern Africa (Visagie, Eide et al. 2017). To test our hypotheses, we analyzed a subset of cases and sociodemographic variables within the Living Condition Studies for Botswana and Swaziland (Table 4.1) (Eide 2011, Eide 2016). Living Conditions Studies (LCS) are nationally representative surveys that capture a wide range of social and economic living conditions of people with disabilities. These surveys not only aim to measure economic and material status but also the degree to which people with disabilities participate in major life activities (i.e., education, employment, community) and realize their human rights, including the right to health care and AT (Eide 2014). According to the LCS reports, over half of the total populations of people with disabilities in Botswana (59.1%) and Swaziland (57.3%) reported that they needed AT (Eide 2011, Eide 2016).

As of December 2017, LCS have been carried out in 9 countries since 2004, primarily within Southern Africa, and offer the most comprehensive snapshot of AT access in Southern Africa to-date. Botswana and Swaziland were selected because the studies were completed most recently among the 9 LCS studies, permissions were obtained to conduct the secondary analysis, and sample size was adequate for performing logistics regression.

Table 4.1 Living Conditions Studies in Botswana and Swaziland

Country	Implementing partners	Data collection	Included Cases
Botswana	The Botswana Federation of the Disabled (BOFOD), Southern Africa Federation of the Disabled (SAFOD), University of Botswana, Statistics Botswana, Office of the President – Botswana, Norwegian Federation of Organizations of Disabled People (FFO), SINTEF.	2012-14	486
Swaziland	The Federation of Organizations of the Disabled in Swaziland (FODSWA), Central Statistical Office.	2009-10	332

Cases selected for inclusion were individuals with disabilities 15 years of age or older who reported needing AT device services. We excluded data from persons under 15 years because the surveys did not include questions about employment about education - two factors examined in this study. Through applying logistics regression, we were able to identify the most important demand-side characteristics that explain AT access in each country. While some comparisons are made between the countries, separate logistics regression models were developed because each country has a distinct profile (Table 4.2), and data collection took place over 3 years apart.

Table 4.2 2010 World Bank - World Development Indicators

	Botswana	Swaziland
Total population (millions)	2.0	1.2
Population density (people per sq. km of land area)	3.6	69.9
Poverty headcount ratio at national poverty lines (% of population)	19.3%	63.0%
GNI per capita, Atlas method (current US$)	$5,570	$3,070
Income share held by lowest 20%	2.8%	4.0%
Life expectancy at birth, total (years)	60	51

Source: https://data.worldbank.org/

As shown in Table 4.2, Botswana is sparsely populated and the gross national incomes (GNI) per capita is nearly double that of Swaziland. Swaziland is densely populated and reports 63% of the population living below the poverty line.

4.2 METHODS

Living Conditions Study Survey

The original questionnaire for the LCS was based on two instruments: 1) a national disability survey for South Africa (Schneider M 1999), and 2) a study on living conditions of the general population in Namibia (National Planning Commission 2000). Revisions were then made to this questionnaire to ensure relevance within each country where it was implemented. SINTEF Technology and Society worked in partnership with FFO, SAFOD, national disability organizations, researchers and central statistical offices, to implement studies and included people with disabilities as supervisor and research assistants.

The target sampling populations for LCS were all private households, excluding institutionalized and homeless people. In both Botswana and Swaziland, a two-stage sampling design was applied. First, enumeration areas (EA) were identified within the national sampling frame based on the most recent census. In both countries, the central statistics office provided the sampling frame. Next, a maximum of 20 household were randomly sampled within each EA to reach the calculated sample size required to produce reliable estimates. An average of 10 of these 20 households had at least one member with a disability.

Outcome variable

A subset of questions in the LCS were analyzed in order to identify factors associated with AT access. The outcome variable of AT access was captured in the following survey question:

Which services, if any, are you aware of and have ever needed/received?

1. *Assistive devices service (e.g. Sign language interpreter, wheelchair, hearing/visual aids, Braille etc.)*
    A. *Needed service 1=Yes, 2=No*
    B. *Received service 1=Yes, 2=No*

Cases that responded Yes to 1A. were included for analysis in this study (Table 4.1). The dichotomous outcome variable is 1B. captures those who received and did not receive AT.

Explanatory variables

Based on a review of the AT and health services literature from Africa, a number of potential explanatory variables were identified including economic status (Amedofu, Awuah et al. 2004, Laviers, Omar et al. 2010), location (rural vs. urban)(Kiwanuka, Ekirapa et al. 2008, He, Abdou et al.

2012, Bozzani, Griffiths et al. 2014, Visagie, Eide et al. 2017), education level (Amedofu, Awuah et al. 2004), age, gender, and type of disability (Eide and Øderud 2009, Visagie, Eide et al. 2017). We also elected to include the severity of disability scale to explore the correlation between disability severity and AT access.

In the LCS, disability type was measured by the six questions developed by the Washington Group on Disability Statistics (Loeb 2016), and socioeconomic status was measured in three variables:

- Possession scale - measured ownership of common household items
- Dietary diversity scale - measured types of food intake over the last 2 weeks
- Access to information scale - measured access to common information sources

Descriptions of select explanatory variables are provided in the Appendix B.

Statistical Analysis

Given the paucity of evidence on AT access specific to Southern Africa, we were not able to develop a specific hypothesis about the order or importance of explanatory variables. Therefore, we applied the statistical (stepwise) logistic regression approach with a bivariate association criterion of $p <. 20$, as recommended by Hosmer and Lemeshow (2000). All potential explanatory variables were analyzed using SPSS bivariate correlation and those that exhibited $p <. 20$ were included in the final logistic regression models. We then assessed the model's goodness of fit with the Hosmer & Lemeshow test. SPSS Statistics 24 software was used for all statistical analysis.

4.3 RESULTS

Characteristics of individuals who needed assistive technology

In Botswana, 574 individuals with disabilities reported needing AT, and 486 of these were 15 years of age or older. Likewise, 496 reported needing AT in Swaziland of which 332 were 15 years or older. Tables 4.3 and 4.4 provide the characteristics of individuals with disabilities (age >= 15 years) and the dependent variable of AT access. As shown in Table 4.3, 44% (Botswana) and 67% (Swaziland) of the people who needed AT did not receive it. The most common type of disability reported in both countries was difficulty with *Walking/climbing steps* (mobility limitation).

Table 4.3 Characteristics of individuals (15+) who needed AT: Frequencies

	Botswana		Swaziland	
	N	%	N	%
Total N	486	100.0	332	100.0
AT access (Dependent variable)				
Received AT	272	56.0	104	31.3
Did not receive AT	214	44.0	222	66.9
Missing	0	0	6	1.8
Gender				
Female	216	44.4	180	54.2
Male	263	54.1	152	45.8
Missing	7	1.4	0	0
Locality				
Urban/City	311	64.0	89	26.8
Rural	174	35.8	243	73.2
Missing	1	0.2	0	0
Received a formal primary education				
Received	289	59.5	113	34.0
Did not receive	188	38.7	132	39.8
Missing	0	0	87	26.2
Employed or receiving social grant *				
Yes	217	44.7	74	22.3
No	267	54.9	256	77.1
Missing	2	0.4	2	0.6
Difficulty in: *				
Seeing	169	34.8	73	22.0
Hearing	99	20.4	62	18.7
Walking/climbing steps	324	66.7	216	65.1
Remembering/concentrating	111	22.8	121	36.4
Self-care	214	44.0	119	35.8
Communicating	98	20.2	87	26.2

Table 4.4 Characteristics of individuals (15+) who needed AT: Descriptive statistics

	Botswana			Swaziland		
	N	Mean	SD	N	Mean	SD
Age	482	48.2	21.4	332	35.2	18.1
Socio-economic status (SES) indicators *						
Possession scale (0-26)	483	8.3	4.9	321	8.4	4.8
Dietary diversity scale (0-12)	468	8.3	2.4	322	8.4	3.0
Access to information scale (0-6)	429	3.3	1.7	319	3.6	1.8
Activity limitations scale (0-18) *	470	4.4	2.7	329	4.1	2.6

*See Appendix B for description of explanatory variables.

Characteristics of assistive technology acquisition

In both Botswana and Swaziland, the vast majority of recipients of AT reported receiving personal mobility devices (80.1% and 80.8%, respectively). In Botswana, the primary source of AT was the government health service, and AT was usually provided for free. In Swaziland, private suppliers were the most common source identified by recipients of AT (32.7%), whereas the government health service provided AT to only 11.5% (Table 4.5).

Table 4.5 Individuals who received AT: type and acquisition

	Botswana		Swaziland	
	N	**%**	**N**	**%**
Total N	272	100.0	104	100.0
Type of AT				
Sensory	19	7.0	6	5.8
Communication	5	1.8	2	1.9
Personal mobility	218	80.1	84	80.8
Other *	9	3.3	1	1.0
Missing (No Type of AT Identified)	32	11.8	16	15.4
Source of AT				
Private	38	14.0	34	32.7
Government health service	123	45.2	12	11.5
Other government service	25	9.2	9	8.7
NGO	27	9.9	11	10.6
Other	34	12.5	19	18.3
Missing	33	12.1	19	18.3
Acquisition of AT **			n.a.	n.a.
Bought it myself	42	15.4	n.a.	n.a.
Bought by someone else	21	7.7	n.a.	n.a.
Given for free	184	67.6	n.a.	n.a.
Missing	33	12.1	n.a.	n.a.

n.a. = not applicable

*Other includes household items, handling products & goods, and personal care & protection products.

**This survey question was not included in the LCS survey for Swaziland.

Access to assistive technology

Bivariate regressions were conducted to identify variables that were associated with AT access, with a Pearson chi square value criterion of < .20. Table 4.6 shows positive and negative correlations of factors that met the criterion (p <.20) in boldface.

Table 4.6 Bivariate correlations of AT access in Botswana and Swaziland

	Botswana			Swaziland		
	N	Pearson's	Sig. (2-tailed)	N	Pearson's	Sig. (2-tailed)
Gender – Female	475	- 0.065	**0.156**	326	-0.015	0.785
Age	482	-0.050	0.276	326	0.109	**0.050**
Locality – Urban/City	481	0.081	**0.076**	326	0.058	0.295
Received a formal primary education	475	0.157	**0.001**	239	0.173	**0.007**
Employed or receiving grant	480	0.051	0.263	326	0.219	**0.000**
Possession scale	479	0.161	**0.000**	315	-0.067	0.234
Dietary diversity scale	468	0.079	**0.090**	316	-0.045	0.422
Access to information scale	429	0.092	**0.058**	313	-0.051	0.370
Activity limitations scale	466	-0.010	0.826	323	-0.090	**0.108**
Seeing	479	-0.192	**0.000**	324	0.030	0.590
Hearing	473	-0.151	**0.001**	324	-0.082	**0.139**
Walking/climbing steps	477	0.371	**0.000**	323	0.238	**0.000**
Remembering/concentrating	472	-0.156	**0.001**	324	-0.250	**0.000**
Self-care	477	0.046	0.313	324	-0.050	0.372
Communicating	473	-0.101	**0.028**	324	-0.159	**0.004**

For Botswana, four variables were excluded from the model based on the $p < 0.20$ criterion: Age, Employed or receiving grant, Disability severity scale, and Difficulty in self-care. For Swaziland, seven variables were excluded: Gender, Rural or urban, Possession scale, Dietary diversity scale, Access to information scale, Difficulty in seeing, and Difficulty in self-care.

The full models for both Botswana and Swaziland shown in Table 4.7 are a good fit based on the Hosmer-Lemeshow Test chi-square significance of .227 and .225, respectively (see Appendix B for goodness of fit statistics).

For Botswana, the full model explains the outcome of AT access with 74.2% accuracy in comparison to 57.9% in the null model. Likewise, in Swaziland the full model explains the outcome with 71.3% accuracy in comparison to 64.6% in the null model.

Table 4.7 Variables in full models for Botswana and Swaziland

	Botswana			Swaziland		
Explanatory variables	**N**	**Exp (B)**	**[95% CI]**	**N**	**Exp (B)**	**[95% CI]**
Gender – Female	475	.749	[.464 - 1.208]	326	n.a.	n.a.
Age	n.a.	n.a.	n.a.	326	1.007	[.991 - 1.023]
Locality – Urban/City	481	1.293	[.751 - 2.224]	n.a	n.a.	n.a.
Received a formal primary education	475	1.876*	[1.132 - 3.108]	239	1.683	[.900 - 3.147]
Employed or receiving grant	n.a.	n.a.	n.a.	326	1.919*	[1.029 - 3.578]
Possession scale	479	1.110**	[1.030 - 1.196]	n.a.	n.a.	n.a.
Access to information scale	429	.869	[.715 - 1.056]	n.a.	n.a.	n.a.
Dietary diversity scale	468	.972	[.866 - 1.090]	n.a.	n.a.	n.a.
Activity limitations scale	n.a.	n.a.	n.a.	323	1.129	[.898 - 1.419]
Seeing	479	.507**	[.304 - .845]	n.a.	n.a.	n.a.
Hearing	473	1.358	[.713 - 2.589]	324	1.555	[.595 - 4.060]
Walking/climbing steps	477	6.383***	[3.610 - 11.285]	323	3.183**	[1.382 - 7.331]
Remembering/ concentrating	472	.517*	[.282 - .948]	324	.321*	[.132 - .782]
Communicating	473	.636	[.335 – 1.209]	324	.577	[.195 – 1.705]
Constant		.353	n.a.		.105***	n.a.

n.a. = not applicable

*<.05

**<.01

***<.001

The Botswana model shows that the factor with the strongest association to AT access is disability type, specifically those reporting some level of difficulty in *Walking/climbing steps.* Survey respondents who had a difficulty in *Walking/climbing* steps were 6.4 times more likely to have access to AT than those who did not report this type of difficulty. However, those who reported difficulty in *Seeing* and *Remembering/concentrating* were over 50% less likely to access AT. In addition, those who completed formal primary education were nearly twice as likely to have access to AT than those who did not complete primary education. The possession scale was also significantly associated with AT access though shows little change in likelihood. For every unit increase (O-18 possessions), respondents were 1.11 times more likely to have AT access. When controlling for other variables, gender, location, and socioeconomic status variables (i.e., access to

information, dietary diversity), and some disability types (i.e., hearing, communicating) were not significantly associated with AT access.

Similar to Botswana, the Swaziland model shows that the factor with the strongest association with AT access was disability type (i.e., difficulty in *Walking/climbing steps).* Survey respondents who had a difficulty in *Walking/climbing* steps were 3.2 times more likely to have access to AT than those who did not report this type of difficulty. However, those who reported difficulty in *Remembering/concentrating* were 58% less likely to access AT. The only other significant explanatory variables of AT access in Swaziland was *Employment/receiving grant.* Those who were employed, receiving disability or other grant were nearly twice as likely to access AT as those who were not employed or receiving grant. Unlike Botswana, education status was not found to be significantly associated with AT access in Swaziland when controlling for other variables.

While our statistical model shows that disability type (i.e., mobility restrictions) is the most important explanatory variables of AT access in both countries, there is a large unmet need for AT across all disability types in both countries, including those who report difficulties with *Walking/climbing steps* (Figures 4.1 and 4.2). Mobility is also the category with the highest total number of individuals without access to AT in both countries (Botswana=101, Swaziland=126).

Figure 4.1 Access to AT by disability type in Botswana

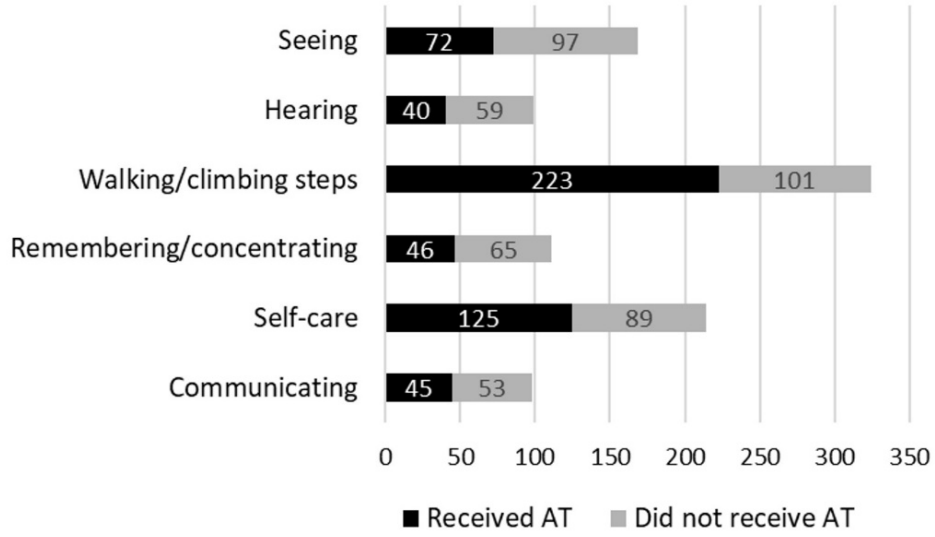
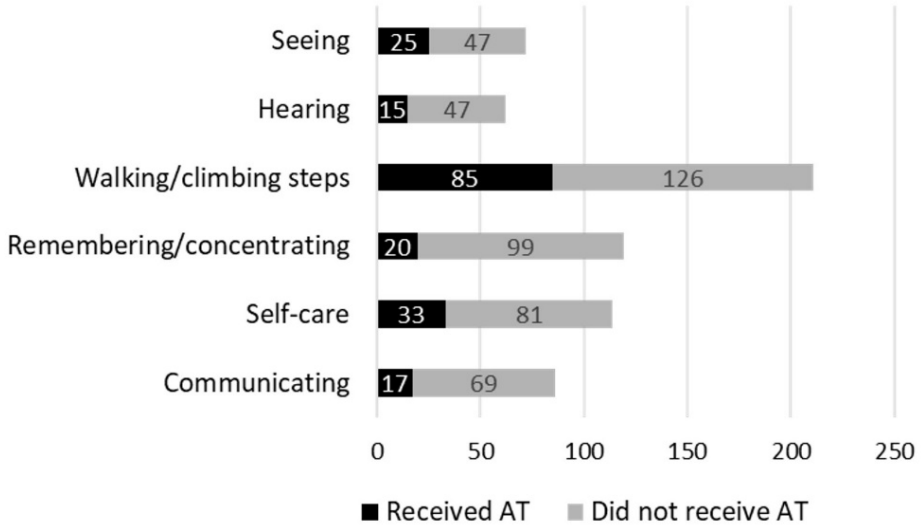


Figure 4.2 Access to AT by disability type in Swaziland



If we examine the subgroup of people with mobility limitations who received AT (Botswana = 223; Swaziland=85), we see that many reported having other non-mobility types of disabilities, and that personal mobility AT dominated across all these other disability types (Figures 4.3 and 4.4). This shows that the type of AT received often does not correspond with non-mobility types of disability, further demonstrating the dominance of personal mobility devices in the AT sector.

Figure 4.3 Disability by AT type: Recipients of AT with mobility limitations in Botswana

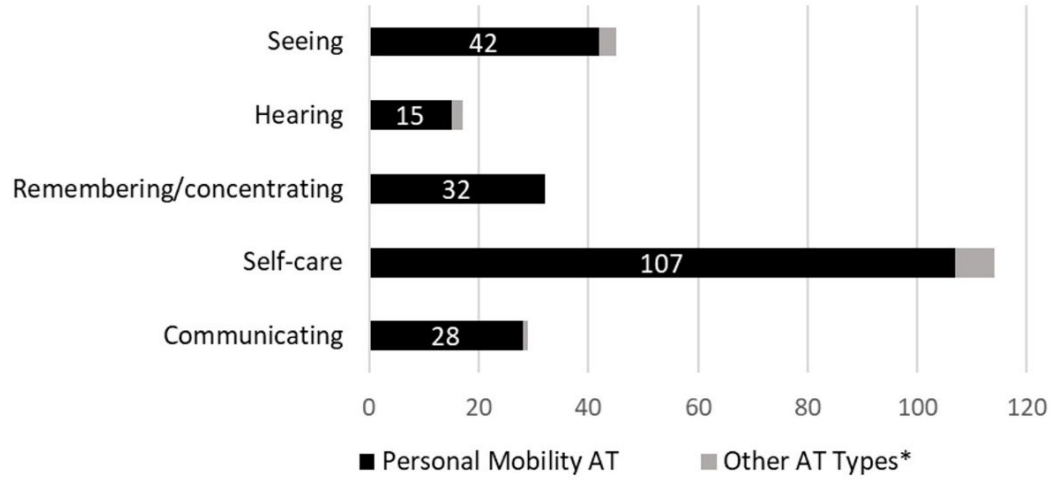
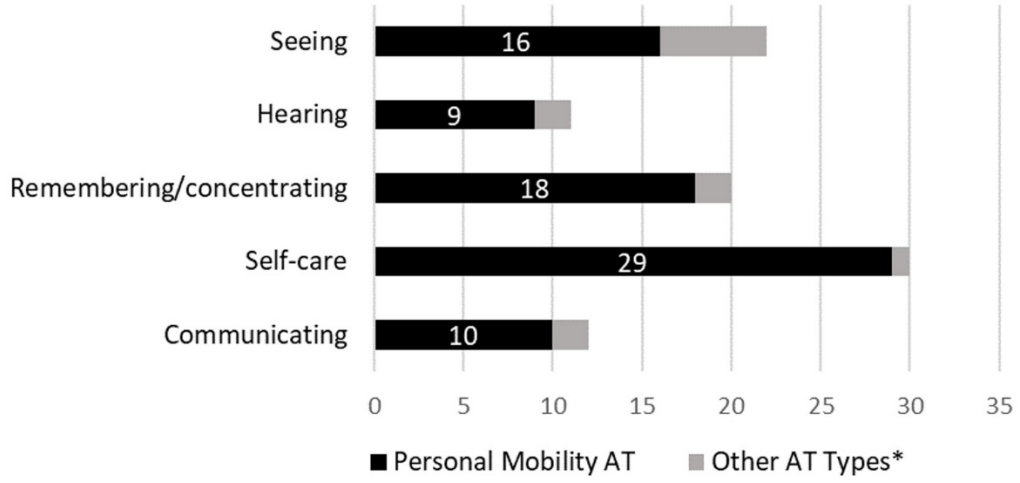


Figure 4.4 Disability by AT type: Recipients of AT with mobility limitations in Swaziland



* Non-personal mobility AT such as sensory, communication, household items, handling products & goods, and personal care & protection products.

4.4 DISCUSSION

These statistical results serve to identify factors that are associated with AT access in Botswana and Swaziland. The most notable finding in both countries is that people with mobility restrictions are most likely to access AT, irrespective of all other sociodemographic factors such as age, gender, socioeconomic status, education level or disability severity. While there is a large unmet need for all types of AT in the both countries, the current coverage levels of AT are not proportional to prevalence of disability types (mobility, seeing, communication, etc.). For example, in Botswana 60% of those with hearing difficulties and 31% of those with mobility difficulties did not have access to AT. In addition, for recipients of AT who had mobility limitations in combination with other types of disabilities, the type of AT received was heavily dominated by personal mobility AT regardless of what may have been the primary disability type (e.g., Seeing).

An explanation for higher AT access among those with mobility difficulties is that mobility is the most prevalent type of disability in both countries (Table 4.3) and in other Southern African countries (Mont 2007, SINTEF 2013), and has thus logically has received the most attention and resources within the regional AT sector. This finding also reflects a number of global AT trends. First, there is a greater awareness of and access to mobility devices (wheelchairs, crutches, prosthetics) in Southern Africa and other LMICs than other categories of AT such as for hearing, vision, communication, and cognition (Rios, Miguel Cruz et al. 2014, Visagie, Eide et al. 2017). Second, international agencies, NGOs and charity organizations have devoted greater financial resources to mobility devices (i.e., wheelchairs) than other types of AT (WHO 2011, USAID 2016). Finally,

evidence reviews on AT research in LMICs show that the research community has also prioritized mobility studies over other AT categories (Borg, Lindstrom et al. 2011, Marasinghe, Lapitan et al. 2015, Matter, Harniss et al. 2017). This focus on mobility devices is starting to expand with increased awareness about the needs and rights of broader populations who benefit from AT such as people who are aging (Garcon, Khasnabis et al. 2016), people with intellectual, development or mental health impairments (Boot, Dinsmore et al. 2017), and people with rare disabilities (e.g., albinism) (Kayange and Matter 2017).

The emphasis of the AT sector on mobility devices is most pronounced in Botswana where a person with a mobility impairment is over six times more likely to have access to AT than a person with a non-mobility type of disability. Given that the government health service was the source of AT for over 45% of AT recipients, it is likely that national AT budgets are devoted to a narrow range of mobility-related AT (i.e., wheelchairs, crutches, walkers). Expanding the range of AT covered by the relevant ministries within the public sector (i.e., health, social development and education), and provided by development partners is one of the aims of the WHO GATE initiative (WHO 2015). To achieve this aim GATE launched the Priority Assistive Product List (APL) (WHO 2016b), a list of 50 essential assistive products that, if provided, propose to address the greatest unmet AT needs globally.

Another key finding of this study is that both the unmet AT need (percentage that did not receive AT) and explanatory factors of AT access vary by country. A higher percentage of people received AT in Botswana (56.0%) than Swaziland (31.3%). This is not surprising given the lower development indicators for Swaziland as shown in Table 4.2. There were only two common explanatory variables in both Botswana and Swaziland models; 1) those with difficulty in *Walking/climbing steps were 6.4 and 3.2 times more likely to access AT)* than those without mobility limitations, and those with difficulty in *Remembering/concentrating* were 50% and 58% less likely to access AT than those without this limitation. In Botswana, difficulty in *Seeing* was also negatively associated with AT access, and completing a formal primary education and having more possessions were positively associated. In Swaziland, *Employment/receiving grant* was the only other significant explanatory variable of AT access. This is consistent with previous finding that there was substantial variation in AT access between countries, and that mobility devices are most commonly available (Visagie, Eide et al. 2017). The differences in factors that explain AT access between the two countries may indicate variations in the procurement and distribution mechanisms within each country. The results from this study and other literature (e.g. Visagie et al. 2017) indicate a more developed public sector for AT in Botswana than in Swaziland. Access to AT in Swaziland is most commonly achieved through purchasing on the private market or being given devices through charity/donation-based providers,

while in Botswana one needs to interact with the public system to obtain AT. This may help explain the importance of education in Botswana, specifically that higher education correlates with higher public sector access, because those who are accessing public education are more likely to be informed about and able to access other public services (i.e., health) than those who have not received a formal primary education. Likewise, the importance of employment or receiving a grant in Swaziland could reflect the dominance of the private sector as one has to pay out of pocket to receive AT.

It is important to note that the significance of mobility impairments within both country logistic regression models does not imply that other sociodemographic characteristics such as gender, location and age do not affect access to AT, as all these factors independently have been shown to be associated with AT access in bivariate correlations (Table 4.6). In the above regression models, the impact of other factors is largely mediated by mobility impairments.

4.5 LIMITATIONS

The primary limitations of this study are that both datasets are not recent (i.e., data collection was conducted in 2012-14 in Botswana and 2009-10 in Swaziland), and the survey question for the outcome variable did not specify a timeframe so respondents could be referring to AT access at any timeframe in the past. Other limitations include possible missing explanatory variables (e.g., access to transportation), self-reported data could be subject to recall and self-report bias, and low levels of awareness about less commonly available type of AT such as AT for communication or cognition resulted in underreporting. In addition, datasets from only 2 of the 15 countries in Southern Africa may not be representative of the region as a whole. Despite these limitations, this study provides evidence that the AT sector in Southern Africa is heavily dominated by mobility devices, so much so that none of the tested sociodemographic characteristic (e.g., age, gender, locality, education level) explain AT access as strongly as type of disability.

4.6 CONCLUSIONS

Governments and other stakeholders in the AT sector in Southern Africa must prioritize AT to address the large unmet demand across all types of AT, in order to meet obligations of the CRPD and the Sustainable Development Goals. These findings also provide support for expanding the range of AT products provided so that people with hearing, seeing, self-care, communication and cognition difficulties have equal access to AT as those with mobility impairments. A step toward achieving these aims is to inventory AT product types that are commonly covered through the public sector in each country, and identify common gaps (e.g., daily living aids). The Priority Assistive Products List

(WHO 2016b) established by WHO's GATE can serve as an inventory taking tool, that can be adapted to match the unique AT needs and strengths within each country.

Advancing the AT sector within Southern Africa will require a significant investment in resources by the international and global health communities, along with local governments - both to develop a comprehensive understanding of the bottlenecks in AT procurement and service delivery systems, and test and apply system-level inventions.

4.7 AUTHORS CONTRIBUTION TO PAPER

RM designed the study, cleaned the data, performed the statistical analysis, and drafted the manuscript. AE assisted with design, provided background information about the LCS datasets, reviewed the analysis results, and edited and approved the manuscript.

CHAPTER 5: END USERS AND PRODUCT SUPPLY

5.1 INTRODUCTION

Chapters 5 and 6 present the findings of the qualitative sub-study and integrate key insights gained from sub-study 1 (Chapter 3, scoping review) and sub-study 2 (Chapter 4, secondary analysis). The following two chapters provide a comprehensive analysis of the AT sector within Southern Africa that encompasses a broad range of AT types; the role of government, for-profit and non-profit actors in shaping the sector; and dynamics within the AT procurement and provision system.

In order to address the core research question, what works to increase access to assistive technology in Southern Africa? the initial aim was to identify and examine approaches and models that are serving to increase supply and access. It became apparent early in the research process that there were few successful strategies for increasing access to AT and most were small-scale, targeting one type of AT or sector (health). Data gathered through participant interviews and other sources illuminated the multitude of barriers to accessing currently available AT and major constraints to increasing AT supply. Thus, the majority of findings presented in both Chapter 5 and 6 describe unmet needs, AT system deficits and challenges to increasing supply and access.

This focus on the shortcomings within the current AT sector accurately reflects the content of these data but does not directly answer the core research question. Given the lack of evidence on what works to increase access, it was critical to first understand the key constraints of the AT sector in Southern Africa and then examine the existing and recommended solutions in relation to these constraints.

Understanding the major constraints within the AT sector was achieved through applying the AT systems framework that was described in Section 1.3, as many components of the framework are consistent with the major themes of this study. Developing a comprehensive theoretical model of AT access, as originally proposed, was not achieved through this doctoral study. Instead a series of causal maps and summative conceptual models were developed that illuminated major constraints within different components of the AT sector and potential solutions.

Constraints identified within these causal maps were integrated to shape the discussion (Chapter 7), including the recommendations presented as ‘strategic levers’. This integrated synthesis was not exhaustive in terms of pulling together all factors listed in the causal maps. The prominent constraints, relationships and outcomes across these diagrams were grouped to present a more holistic understanding of the phenomenon AT access.

While a wide range of constraints must be addressed to increase AT access, addressing them piece by piece will not achieve the major shifts needed to advance the sector. The strategic levers aim to increase supply and access within the AT sector as a whole across Southern Africa, not just within one building block (e.g., financing), specific types of categories of AT, sectors or countries.

Before beginning to report research findings, a brief review of the primary data sources and organization of findings are provided below.

Data sources

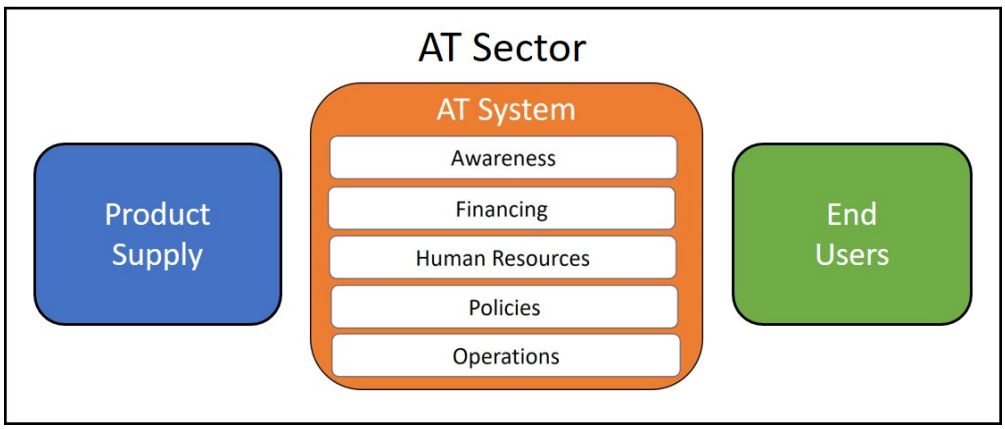
Most data presented in Chapters 5 and 6 are from stakeholder interviews conducted with a representative sample of participants who work in the AT sector in Southern Africa. Participants serving in different roles (direct service providers, leadership) across government, non-profit and for-profits; and with a range of AT experience comprised the sample. See Methods, Section 2.4 for a description of sampling and data collection methods, and a summary of participant demographics and experience.

Data from interviews were combined with information from documentation review, observational data and findings from the two sub-studies covered in Chapters 3 and 4 to yield a more comprehensive understanding of AT supply and access in Southern Africa.

Organization of findings

Findings are grouped into the three broad components of the AT sector: product supply, end users and the AT procurement and provision system (abbreviated as AT system within Figure 5.1). As described in the Methods, Section 2.4, these three sector components came from the analysis of the qualitative sub-study data. This conceptualization places the AT system and associated building blocks within broader AT sector.

Figure 5.1 Three components of the AT sector and five building blocks of the AT system



As shown in Figure 5.1, the central component, AT procurement and provision system, includes five building blocks. These building blocks have been adapted from the AT system framework described Section 1.3 to reflect the data. Building blocks incorporate resources, structures, actors and processes that enable end users to access AT products.

Product supply on the left side of the figure encompasses the sources of AT products, product attributes and supply chain characteristics. On the right side, end users capture the people with disabilities or functional limitations, temporary or long-term, that require AT. The AT procurement and provision system, referred to as the AT system, is the multifaceted bridging component between product supply and end users and thus comprises most findings presented.

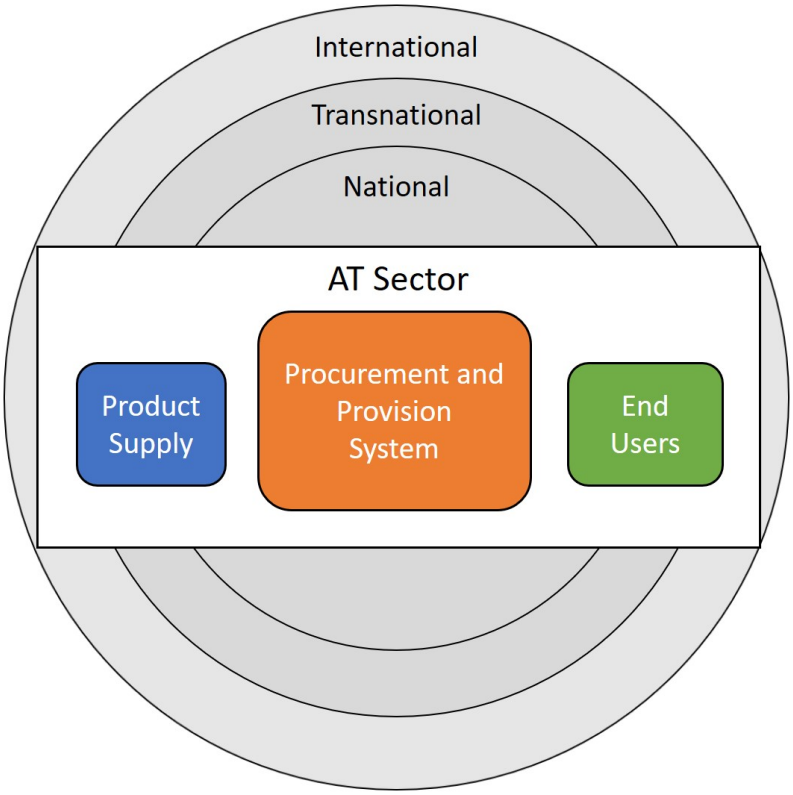
The two outer components, product supply and end users, are covered in Chapter 5. First the common challenges that end users experience when accessing AT are described (5.2). Next a description of AT product supply sources and supply chain characteristics (5.3). Findings presented in both sections capture *what is not working* on the surface level (e.g., the supply of AT is inadequate) and begin to identify to the many causal factors that lead to these outcomes.

In Chapter 6, the comprehensive exploration of AT system yields detailed explanations of the end user experiences and product supply challenges outlined in Chapter 5. The AT system is comprised of five building blocks: awareness (6.2), financing (6.3), human resources (6.4), policies (6.5) and operations (6.6.).

Solutions to increase AT access in Southern Africa identified by participants, from small local programs to international strategies, are woven across the three components.

A synopsis of key findings is provided at the end of each section that includes a causal map of key constraints. These models aim to capture the complexity and causal relationships between factors that determine key characteristics within different components of the AT sector. Most factors will be specific to the AT sector though some will be contextual, meaning not specific to AT (e.g., fluctuating exchange rates). To depict the AT sector within larger national, transnational and international contexts that are not specific to AT, three widening circles have been included in Figure 5.2 below. For the purposes on this research, transnational is limited to the Southern African region. These contextual circles were adapted from the health system levels presented in Table 1.3.

Figure 5.2 Three components of the AT sector within the broader context



The synopses and solutions presented throughout Chapters 5 and 6 will be combined with findings from Chapters 3 and 4 and then synthesized in the Discussion Chapter 7. Chapter 7 serves to interpret the key obstacles to advancing the AT sector in Southern Africa and identify ways to minimize or circumvent these obstacles.

5.2 END USERS

In this section the common experiences of AT end users and underlying causes of these experiences are identified and described. One key underlying factor identified is inadequate AT funding. Both financing available from the AT system and purchasing power of end users will be described following common end user experiences. Strategies identified by interview participants to address the unmet needs of end users will also be described.

In this section and throughout the thesis, end users are referred to as patients, clients, customers and consumers, depending on the nature of their relationship with AT suppliers and providers. The end users discussed below are aware of AT. This section does not include those who do not try to access AT because they are not aware that AT is a possibility. Lack of AT awareness will be covered in detail in Section 6.2.

Common experiences of end users when trying to access AT

Lack of AT access

It is known from the Living Conditions Studies that most people who need AT in Southern Africa do not get access (Eide 2014). Chapter 4 showed that among the sociodemographic variables tested, the type of disability was the most important factor in determining AT access. Specifically, those with mobility limitations are more likely to access AT than those with non-mobility types of disabilities (e.g., vision, hearing, communication, cognition).

Inadequate AT supply is the most obvious reason why most end users do not gain AT access. In this section, inadequate supply includes AT products that are made locally or made overseas and imported into Southern Africa. Operational inefficiencies, fragmentation of AT provision and inaccessibility of AT services also contributed to lack of access. Bureaucratic processes, particularly within government provision can be inefficient and thus delay the receipt of AT. End users also can find it difficult to know where and how to access AT for there are numerous providers across all three sectors (i.e., government, non-profit and for-profit) that provide select types of AT and cater to different audiences. Inaccessibility of AT services pertains to both the geographical location of services and level of accessible design of services.

As found through the AT-Info-Map project, the vast majority of AT providers within all three sectors (public, for-profit, non-profit) are located in urban areas thus increasing the travel distance and cost for people residing outside these areas (see Appendix D).Within the public health system, some AT is only available and repaired through select tertiary or central hospitals which requires extensive travel for end users outside that geographical area. The lack accessible transportation poses yet

another barrier for some end users to reach AT providers, particularly those with mobility limitations. The most common form of transport used in Southern Africa, the minibus or 'combi', is not accessible in design and drivers may choose to not pick up someone using a mobility device.

Some end users can receive free transportation for accessing rehabilitation and AT as part of government compensation schemes, but the accessibility of this service is not known. In Zimbabwe, two participants reported that the War Victims Compensation Fund and Accident Prevention and Workers' Compensation Scheme cover transportation to and from AT and rehabilitation service providers.

Long wait time

A person seeking AT is likely to wait many months to receive the needed device. In the most extreme cases the wait can be many years. As expressed by two interview participants:

> *The waitlist in Kimberly [province in South Africa] is 4 years for wheelchairs. (Leadership, for-profit)*

> *In the 5 years I worked at [hospital] not a single person got a prosthesis…and I don't know how long it was before I started that there were no prosthetics. (Direct service, government)*

Waitlists are kept by many public and non-profit providers of AT in Southern Africa though these lists are not aggregated to determine demand and rarely used to inform procurement decision making.

A few participants explained that waitlists have been developed out of necessity because the quantity of products available was not enough to meet the demand. Waitlists are used to distribute products on a first come first serve basis or help prioritize clients based on types of AT that become available.

A long waiting period can be associated with negative clinical outcomes. For example, if someone in need of a leg prosthesis doesn't receive the device until a year after the assessment is made, the leg may no longer fit properly and cause pressure sores. Long wait times reduce ability to access major life activities include lack of access to education, reduced productivity (e.g., workplace performance) and decreased overall social participation. As one provider stated:

> *We have had no surgical boots for 2 years. I have had kids dropout of school because they can't get there. Some kids I have put in wheelchair because of no calipers [leg braces]. (Direct service, government)*

While lack of AT funding resulting in inadequate supply was mentioned most often as the cause of long wait times, operational inefficiencies with procurement and provision were also described. For example:

Employers are motivated to get AT for the job but there is still long red tape. Depending on department it could take 2 years to receive AT…Someone can get a job but can't do the job because they can't use their computer. Then employees become frustrated because they can't do the job. They want to be active. (Direct service, for-profit)

Receipt of inappropriate AT

Inappropriate AT products were reported to be common place in Southern Africa. AT can be inappropriate in that it does not match the clinical and functional needs of the end users, and/or not well-suited to the context. The context includes the natural and built environment such as terrain, types of housing, transportation systems, information and communication infrastructure, as well as cultural and social norms. Providing inappropriate devices result in secondary conditions (e.g., pressure sores) and a high rate of product abandonment.

Several examples were provided by participants of inappropriate AT products. Examples of wheelchairs included the wrong size of wheelchair, a lightweight folding wheelchair that lacked strength and durability for outside use, non-foldable heavy wheelchairs that could not be put on public transport, wheelchairs that lack postural support and/or not adjustable (e.g., arm and foots rests), and a basic wheelchair provided to a person with higher level seating needs. Examples of other products that were a mismatch for the environment included an IPAD that could not be used within the home due to lack of reliable electricity and risk of theft, crutches with nondurable ferrules, and a simple hinge prosthetic knee that was not suitable for use on rugged terrain. Inappropriate was equated with 'cheap', 'basic' or 'low quality' and most participants stated that these products were manufactured in Asia.

Inappropriate AT imports from Asia, specifically China and India, have increased due to economic trends, lack of regulations and enforcement and lack of awareness about appropriate AT. A prosthetist in Zimbabwe described how the economic crisis has resulted in the government buying prosthetic components from China instead of Germany and that these components were 'cheaper but they are not durable'. Another participant shared similar perceptions:

If they [countries surrounding South Africa] had money, they would import the South African locally manufactured or the ISO standard wheelchairs but what is most affordable are the cheap imports from the East. (Direct service, for-profit)

Actors from all three sectors (non-profit, for-profit and public) were identified in examples of bringing inappropriate products into Southern Africa. Donors were often the first source of inappropriate AT mentioned during interviews, though it was not clear if they were responsible for bringing in the highest quantity of inappropriate products into Southern Africa. Most donors are

international or local non-profits that secure external funding, often in the form of grants, to purchase and donate AT. Donations can be channelled through government ministries, individual government officials and/or a range of local organizations (e.g., DPOs, churches, schools). Donors can also be private philanthropic individuals who not affiliated with any non-profit organization. Types of inappropriate donations described by participants included new and used mobility devices, spectacles and hearing aids - all with varying levels of quality. A few participants reported that progress has been made in reducing inappropriate AT coming from donors through awareness raising and training, particularly in South Africa, but that this progress has not always linear. As stated by one participant:

> *A large part of it [inappropriate AT] is awareness and education. It's often one step forward and three steps back. You will be building wheelchair services in Malawi, for example, and government is gradually learning and improving services and then there is a political drive and they will buy rubbish wheelchairs to be in favour. Or you have another NGO that will come in, and the desire to see immediate smiles on people's faces, but no thoughts of sustainability. So even international NGOs are coming in with containers and containers of inappropriate wheelchairs to handout. (Leadership, non-profit)*

Participants with experience in the public sector reported that some government officials procure the lowest cost option for AT devices which are often inappropriate. Government officials who make procurement decisions often have limited knowledge about AT and the need for appropriate devices. Even when public tender specifications include a range of appropriate product options there can be cases when officials selecting the products do not adhere to these specifications. Tenders are procurement contracts for specific goods and services. An occupational therapist working within the public health system described the purchasing decision by the procurement official in her district:

> *The way he [procurement official] looked at it was, 'on tender there are all these nice devices…but we want to get as many wheelchairs out of the budget as possible, so we are just going to buy the basic folding chair', which is useless in a rural area. (Direct service, government)*

In the for-profit sector, participants reported that there are numerous small businesses and shops throughout Southern Africa that are importing a range of low-cost products from Asia such as wheelchairs, crutches, walkers, orthopaedic braces and spectacles. The lack of regulations and/or the lack of capacity to enforce regulations means that nearly any businessperson can procure and provide a wide range of AT products, regardless of how appropriate. Regulations that affect the appropriate provision of AT are discussed in more detail under Section 6.5 Policies.

Conversely there are a handful of companies, primarily in South Africa, that specialize in the AT market and have staff who have AT expertise. These personnel have developed clinical and/or technical knowledge and skills on select types of AT products and related services such as low vision aids. Companies that specialize in AT are more likely to procure appropriate AT products that meet local or international standards and provide timely post-sale services to their customers. Post-sale services include training, technical assistance, repair and replacement provided after the buyer/end user received the product.

It is important to note that appropriate products are often inseparable from services such as assessments, fitting, adaptation, user training, follow-up, repair and maintenance. Without adequate services, appropriate products can still be harmful to the end users. Some products categories are low-risk and require no services such as a basic wheelchair that is only used to transport users within an airport. The quantity and quality of AT direct services needed to ensure appropriate provision are covered in more details under Section 6.4 Human resources.

Lack of sustained use

Repair and replacement services were identified as critical for sustained use of AT received by end users. However, these services are often not available or affordable. It was reported that even when products had a warranty (e.g., 2 years guarantee to repair or replace), the cost of returning the product to the provider or supplier is unaffordable for the end user. Repair and replacement costs can exceed the product price when costly international shipping is involved. In rare cases product warranties were honoured. One example was of a local supplier that took responsibility for repair and replacement costs as part of post-sale services. Another example was when an end user had enough financial resources to return to product to the manufacturer. Regardless if a product is under warranty or not, the lack of repair services and spare parts within the region pose major barriers to sustained use of available AT.

Products that are not locally repairable have resulted in abandoned devices. As observed in Zimbabwe, a large school classroom was being used as a storage space for mobility devices in disrepair and these devices were piled from floor to ceiling. Refurbishing these abandoned devices has become one small-scale strategy implemented by a few non-profits in Zimbabwe.

South Africa has made efforts to address the repair gap through requiring products purchased through government tenders to be locally reparable. This requirement has resulted in increased government purchasing from locally manufactured wheelchair companies. In countries outside of South Africa where local manufacturing is small-scale and not as sophisticated as South Africa, the

locally made products that are locally reparable may be preferred to higher quality imports. As expressed by one provider:

> *With work that we've done in Zimbabwe, Tanzania and Kenya, the local production of wheelchairs, though they are much heavier and much more clumsy than local comparisons in South Africa, it's still for me a better product to work with than the imported products because they are more sturdy, stronger, there designs are overall better, and can be repaired locally. (Direct service, for-profit)*

Inadequate AT financing

Inadequate financing, on behalf of end users and the AT system, is an underlying cause of all common experiences of end users: lack of access, long wait time, lack of sustained use and receipt of inappropriate AT.

End user's inability to afford AT

Most end users do not have the financial resources to purchase AT so depend on government or non-profits sources for free or heavily subsidized products. As expected, people residing in areas with high levels of poverty and unemployment experience the greatest financial barrier.

There are often out of pocket costs associated with receiving AT even when AT products are provided free of charge. Transporting to reach provider locations can be unaffordable. When the AT provision process requires more than one appointment, end users may have to cover the costs of multiple trips or days of consecutive service.

For people with disabilities living in extreme poverty, even a minimal cost to catch a combi (public transport) across town to pick up a free device is not possible. In addition, costs of maintaining or repairing a product can be out of reach for many. For example, replacement batteries for hearing aids provided by a local non-profit in Zimbabwe costs $20-30.

For those who can afford to pay for AT out of pocket, they may select the most affordable AT option irrespective of clinical recommendations. As described above, lowest cost products are often imported from Asia and are inappropriate for the end user and/or the environment. Other end users who have been unsuccessful in accessing AT through government or non-profit sources, find ways to pay for the more expensive appropriate AT provided by a for-profit provider. As stated by one prosthetist:

> *Sometimes we get email from family members. They do not want to go to state hospital. They don't want to wait anymore so they find the money to get help from business sector. (Direct service, for-profit)*

AT system financing

Financing for AT products is limited across all three sectors (government, non-profits, for-profits) across Southern Africa. South Africa has more government funding for AT than surrounding countries, but the amount is still vastly insufficient to meet the needs. Participants identified the low prioritization of AT in funding agendas as the main cause of inadequate AT financing. The financing building block within the AT system will be covered in detail in Section 6.3.

Strategies to address end user AT needs from the perspective of participants

Participants identified a few small-scale ways that AT products were made more affordable, appropriate and accessible to end users:

- Reducing cost: A few participants described how non-profits would allow for a sliding scale or long-term payment arrangements. Some industry suppliers would occasionally provide select products at cost or as donations to customers who could not afford to purchase them. However, discounting costs was inconsistently applied and often based on the judgement of an individual organization or provider.
- Reuse programs: Another strategy was to reuse products. One simple approach implemented by a supplier in South Africa was an online exchange for AT users to sell and buy used accessible information and communication technology (ICT) products. A more complex program set up by a government rehabilitation professional in one province in South Africa involved a client tracking system to identify mobility devices no longer in use, collecting abandoned devices, and repairing and reissuing the devices at community level. Both these reuse solutions served to expedite the provision of AT but are small-scale with limited reach.
- Acts of goodwill: Individual acts of goodwill outside the scope of activities sanctioned by the government, industry or non-profit organizations play a part in AT access. These individuals may pay for the devices, transport AT products to end users or vice versa, and accommodate people traveling a long distance to reach providers. They often use their personal vehicles, money and social networks to provide this support.
- Raising awareness about appropriate AT: Awareness raising targeted at international non-profits served to reduce the amount of inappropriate mobility devices brought into the Southern African region.
- Procuring AT from expert AT suppliers: There are for-profit suppliers that specialize in AT and provide post-sale services such as training and repair. These suppliers are also more likely to provide appropriate devices.

- Homemade AT: A few examples were mentioned by participants of individuals who had handmade their own AT device. There was an exceptional case of a prosthetic leg fabricated out of a stick, modified bucket and wire. A photo of the man with the homemade device was shown to me during an interview.

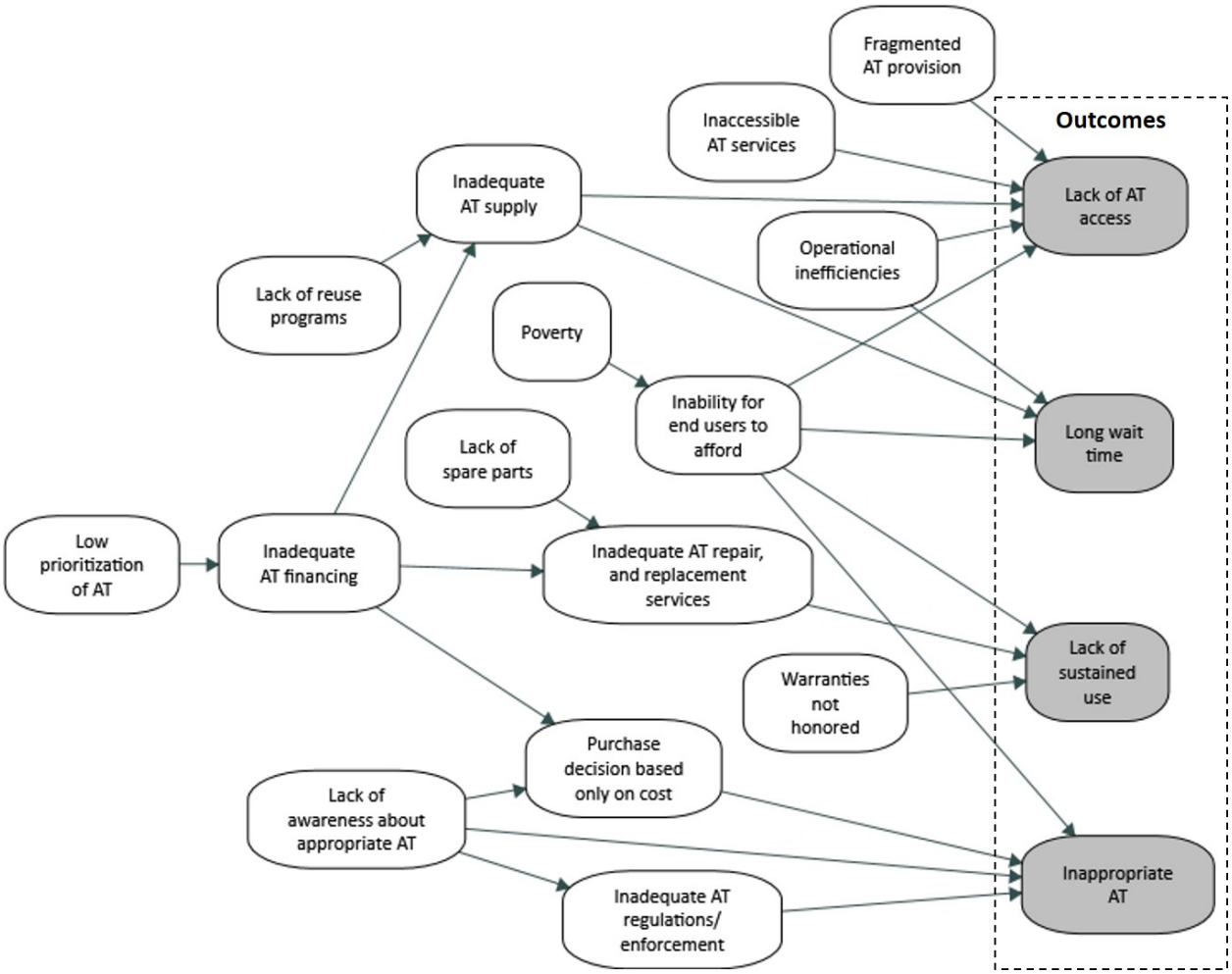
Though these small-scale approaches to increasing AT access are patchwork and inconsistent, they play a major role in AT provision as national strategies have minimal reach.

Synopsis of end users

For end users who are aware of AT there is a path to access AT within Southern Africa but most on this path will not reach an AT solution that enables them to realize their human rights – to education, employment, healthcare, information – or to function within their homes – to move around, communicate, cook, bathe and play. Of those who do reach AT, the wait can be months to years and there are few assurances that the AT received matches the clinical or contextual profile of the individual. End users often cannot afford the AT options available so will go without AT or seek a cheaper and often less appropriate product. Whether appropriate or not, the AT received is rarely a lasting solution due to lack of spare parts, local repair and replacement services.

Those with mobility impairments are more likely to gain AT access than those with non-mobility types of disabilities (see Chapter 4). For end users who do get access to AT, common experiences identified in Figure 5.3 are long wait time, receiving inappropriate products and lack of sustained use. The underlying factors identified that contribute to these experiences (outcomes) are presented on the left side of the figure below. The outcomes are identified by grey rectangles. This same format will be used in all subsequent causal maps.

Figure 5.3 AT end user experience: Outcomes and contributing factors



The underlying factors identified in the examination of end user experiences will be explored further in the following sections. In the next section, (5.3), a comprehensive description of inadequate AT supply will be provided.

5.3 PRODUCT SUPPLY

Product supply covers sources of AT that are available in Southern Africa, key characteristics of the AT supply chain, and barriers and facilitators to increasing AT product supply. The following discussion about AT product supply primarily focuses on the for-profit and public sectors and encompasses both AT products made within Southern Africa and overseas.

The first subsection covers AT that is locally manufactured within one of the Southern African countries. The second subsection is on imported AT that is manufactured outside of Southern Africa. The third subsection addresses supply chain challenges at international, transitional and national levels, and applies to both local and foreign manufactured products. Approaches identified by participants to increase local AT manufacturing and AT imports, as well as to extend the lifespan of available AT through adequate repair and reuse programs, are summarized in the fourth subsection.

Local manufacturing of AT

Participants described a range of AT products that were manufactured locally. Products included aids for daily living (ADLs) such as bath boards, bath chairs, back brushes, grips for laces or buttons; basic communication boards; hearing aid technology; basic orthotics such as a knee brace; and a variety of mobility devices such as wheelchairs, walkers, crutches and walking sticks. Most local manufacturing of AT took place in South Africa with a few examples provided from surrounding countries.

Local manufacturing in South Africa

South Africa is the only country in the region that has the capacity to manufacture select types of mobility devices at a commercial scale, meaning at high enough volumes to supply government tenders and/or sell to major buyers in South Africa or neighbouring countries.

Participants provided a few examples of mobility device suppliers in South Africa who were mass producing AT. These companies focused their manufacturing on both basic appropriate designs and highly customized products and would also import a range of AT products from basic crutches to specialized high-end motorized wheelchairs. Products that were customized for individuals may be best to manufacture locally if expertise was available as ordering from outside South Africa could take months to arrive and small orders increase overall import costs. A representative from a manufacturing business in South Africa described types of products manufactured versus imported:

> *What we target to manufacture are high strength, durable, fairly basic products and we aim to import far for sophisticated products. We don't really want to manufacture, compete with top end products. (Leadership, for-profit)*

Small-scale manufacturing across Southern Africa

Many Southern African countries manufacture AT products at a small-scale. For example, one participant reported that a workshop in Zimbabwe manufactures less than a dozen mobility devices per month. For-profit, public and non-profit organizations were reported to be involved in small-scale local manufacturing. These organization were motivated by the need to reduce product costs and address product gaps. Specifically;

- an international NGO created a local ear mould lab to reduce costs for making hearing aids;
- local DPOs manufactured wheelchairs designed for rural environments;
- staff at a public hospital handmade simple daily living products such as transfer boards and bath chairs because it was difficult to obtain these product through public tendering system;
- and a business made solar powered hearing aids to reduce cost and increase product lifespan.

A representative from the Zimbabwe Albinism Association described a sunscreen[8] that was manufactured locally by a for-profit supplier at a much lower price than imported options:

> *She can manufacture at a lower cost. The normal price at the pharmacy is USD $25-30 and she can manufacture for $5. The same quality…She has her own chemist. She does her normal business every day but does this [manufacturing sunscreen] as part of her corporate social responsibility. (Direct service, non-profit)*

Benefits of local manufacturing within Southern Africa

In addition to addressing gaps in supply, local manufacturing often served to reduce product costs, improve timeliness of receiving products and increase sustained use. Spare parts and repairs were more likely to be locally available if AT was locally made and technical expertise were in closer proximity to end users than for foreign made products. Given the challenges that end users experience in sustaining use of devices, local repairability is important. One participant described wheelchairs made locally of steel tubing could be repaired any type of local shop that had welding capacity so may not need to be returned to the local manufacture for simple repairs.

Even when products were more costly when made locally, creating local jobs was considered value added. As expressed by one participant:

[8] Note that sunscreen is typically not considered AT but is included for this study as it is essential for persons with albinism who are classified as people with disabilities in Southern Africa.

If we were to manufacture our wheelchairs in China we could reduce the cost of production by 1/3 so we could make all our chairs in China instead of here, but the problem is that I create jobs here and the skills in the production process are transferrable. So, I don't believe it's in the interest of the country to outsource it to China. (Leadership, for-profit)

A range of AT stakeholders including DPOs from multiple countries expressed enthusiasm for increasing local innovation and manufacturing. At the Regional Disability Roundtable Forum (Southern Africa Federation of the Disabled 2017) and at AT-Info-Map app testing and training events (2016-18), attendees discussed how local manufacturing could increase AT supply, bring down costs, and provide training and employment opportunities. In addition, engaging people with disabilities as innovators and in product testing serves to improve product designs. Forum participants agreed that people with disabilities have the potential to be product creators and not just consumers of AT. Investing in local AT designers, people with disabilities in particular, would be empowering and counteract the perceptions that foreign AT products and expertise is always better than local, and that people with disabilities do not have the capacity to create their own solutions. As described in a paraphrased statement made at the roundtable:

It is important to unlock creativity and innovation, not just be consumers. It is disempowering to DPOs to always be looking outside for solutions. Not developing your own solutions. (Southern Africa Federation of the Disabled 2017)

A few interview participants at the same event thought that the decision of whether to import or locally make an AT product must be determined case by case based on competitive advantage. Determining which option has the competitive advantage must take into account the purchase price, transport costs, and long-term maintenance and service costs. For example, if hearing aids can be imported a lower cost than the locally made option of same value (in terms of features and quality) but then cost substantially more to repair or replace due to costly shipping of products and spare parts, locally made hearing aids would be the most cost-effective choice.

Challenges to increasing local manufacturing of AT

The largest barrier to developing and scaling up local AT manufacturing is limited financing from all three sectors (government, for-profit and non-profit). Some regional manufacturers described how it is becoming more difficult for locally made products to compete with AT imports due to high costs of equipment, materials and labour. Increasing local manufacturing of AT in surrounding countries was perceived to be more challenging than South Africa due to the lack of overall public financing, high cost of imported equipment and materials, inefficiencies in the transnational supply chain and donations from international NGOs that can undermine local production. When one participant

representing a manufacturing company in South Africa was asked if increasing local manufacturing in surrounding countries was a solution to increasing regional supply, they responded:

> *No. Populations are too small and there are too many middlemen. Just to get steel across borders: Steel lands in Durban. It gets shipped to Joberg. From Joberg it gets shipped across the border to Malawi or Zimbabwe or wherever. Then there are duties at the border for steel because now this is not a wheelchair, so them the wheels and everything gets extra duties at the border. Then from the border it goes to a wholesaler. The wholesaler marks it up and then it sells to the wheelchair production company. Now you have added three additional moneys to this process…*

They continue describing the production process:

> *Manufacturing a wheelchair is quite a complex job, you need decent quality steel, you need powder coating, you need to have fairly good welding, braising, and most of these Southern African countries don't have access to that. (Leadership, for-profit)*

Another participant described how the technical expertise and equipment was available in Zimbabwe to manufacture certain orthopaedic components, but the market demand was too small for this to be profitable.

> *We can contract with local companies to make some [orthopaedic] components but they would take losses. (Direct service, for-profit)*

Lack of government investment in new AT business development was identified by two participants as another reason why local designs and manufacturing were not more common in Southern Africa. One participant stated that the government and public universities do not provide financial support for AT entrepreneurship.

> *I believe people have the skills. What they are lacking in start-up capital. There are even regional organizations where people can go to acquire those skills in AT. (Leadership, non-profit)*

Another participant presented a contrasting view about local human resource capacity, stating that government also needed to invest in skill development:

> *We also lack expertise and skilled manpower. That why I also say that it goes back to the Department of Trade and Industry who must invest in training and development to increase competencies and skills. (Leadership, for-profit)*

In a smaller Southern African country, the government did make investments in new business development which included a few AT companies. However, one participant described how AT entrepreneurs were not able to win government tenders because most were awarded to the same

large companies year after year who often import AT. Tendering decisions were perceived to be influenced by favouritism and to prioritize larger suppliers. Even if their locally made products were more appropriate, affordable and could be repaired locally, suppliers who were importing AT received the government tenders.

> *For you to get the tender you have to know people to who sit on the tender board. For us it's not really transparent. (Leadership, for-profit)*

Furthermore, the process of bidding for a tender was time intensive so absorbed a higher percentage of resources for smaller companies.

A final challenge to increasing local manufacturing is regarding the role of NGO product donations. While local workshops operate at a small-scale within a small market, sales plummet anytime a large donation of competing products enter the local market. This problem was observed in Zimbabwe by one participant who described how local AT manufacturing businesses were developing capacity until AT donations 'killed their business'.

Facilitators to increase the local manufacturing of AT

Increasing overall financing for AT by public, for-profit and non-profit purchasing is needed for local manufacturers to develop and grow. AT financing is needed for both the direct purchase of products and services and for investing in the development of local AT manufacturing businesses. Local manufacturers in South Africa and in Botswana also stressed the importance of reaching the larger transnational market as needs for AT are similar across countries. As expressed by a representative from an AT company in Botswana:

> *The government must assist local companies to enter new markets. We [company] can't survive here with a population of 2 million so we need to penetrate into other countries, we need to have more distribution channels. (Leadership, for-profit)*

The growth in local manufacturing over the past 20 years in South Africa depended heavily on public financing of AT products through a tendering process. Increases in public AT budget, specifically for mobility devices, was achieved through awareness raising and advocacy on behalf of a broad range of AT stakeholders such as rehabilitation professionals, industry suppliers and people with disabilities.

Facilitators identified by participants that could minimize some of the constraints described above are summarized in Table 5.1.

Table 5.1 Constraints and facilitators to increase local manufacturing of AT

Constraints	Facilitators
• Inadequate AT financing from all sectors • Public tender decisions that favor larger importers over local manufacturers	Gradual and consistent increases in public budgets with tenders that procure from local manufacturers (including smaller-scale)
• High cost of imported raw materials, equipment and labor • Regional supply chain inefficiencies	Focus locally manufacturing on products with a competitive advantage when considering the full cost of procurement, provision and sustained use
• Lack of government investment in AT businesses development and growth	Government provide start-up funding, AT workforce training, incentives for local AT manufacturers, access to regional markets and promote locally made products
• Sporadic large product donations by international NGOs	International NGOs ensure AT donations do not undermine local AT manufacturing

Importing AT from foreign manufacturers

Now that local manufacturing of AT has been described, I will now present the main topics that emerged regarding AT products that are made overseas and imported into Southern Africa.

Research participants discussed a range of AT products of varying levels of quality and appropriateness that are imported into Southern Africa. The types of imported products that participants described included range of high-end and high-cost devices such as bath hoists, motorized wheelchairs, sports wheelchairs, aluminium ramps, rollators, full body frames, prosthetic components (e.g., knee joints), digital white canes; accessible ICTs from basic to high-end; spectacles; and low cost mobility and daily living such as basic crutches, walking sticks, bath chairs and grab bars.

South Africa as the primary conduit for imported AT

Most AT products are imported into South Africa for use in South Africa or for export to other Southern African countries. This includes new finished products as well as AT materials, equipment and spare parts needed for local manufacturing and repair.

South Africa has a stronger economy and better developed importation infrastructure than most other countries in the region, hence most AT importers are based in South Africa. Products imported from foreign manufacturers and then cross borders within the region are subject to regional supply chain inefficiencies, as will be described further in the next subsection. Only a few participants from for-profit and non-profit organizations who were based in a surrounding country reported that they were able to import products directly from foreign manufacturers. For example, a prosthetist in Zimbabwe imported prosthetic components directly from China.

Practices of local AT intermediaries (importers and buyers/sellers)

A wide range of AT importers and other intermediaries purchase from foreign manufacturers and sell to actors in the for-profit, public and non-profit sectors. Intermediaries are for-profit buyers and sellers of AT within the supply chain which can includes importers and actors that buy and sell imported AT. China, India, United Kingdom, United States, Canada, Germany, Netherlands and Sweden were identified as the primary countries that manufacture AT for the Southern African markets. Manufacturers that exported higher quality products adhered to international standards, whereas lower quality products, that primarily came from Asia, were less likely to go through any standards certification process.

As expected, intermediaries with more knowledge about AT were more likely to import appropriate devices. Unfortunately, there are many that lack AT knowledge and experience and tend to make AT purchasing decisions based on price and not on other attributes such as quality or appropriateness. The lack of regulations and weak enforcement allow intermediaries to bring AT of any quality into Southern Africa and make AT product recommendations to end users. As on participant describes:

> *In the state service [public] there is a policy that wheelchairs can only be prescribed by someone who is trained but in the private sector anyone can set up shop, and you can make a prescription and as long as you are not saying you are a health care professional. (Direct service, for-profit)*

Providers of AT from all sectors who purchase AT from intermediaries can operate at any scale, from a rehabilitation professional who buys AT for one local for-profit clinic to the national government that is purchasing for the whole country. Complex supply chains with numerous intermediaries make it difficult to identify to most direct pathways that AT products travels from manufacturers to providers. Less direct pathways have more links in the supply chain and thus increases product costs.

One way that individual providers have circumvented the complex and thus costly supply chain is to import AT informally. Two rehabilitation professionals stated that they had brought 'grey imports' into the country for their clients because formal channels were too slow, costly or did not offer a specific product needed. Grey imports are transported through personal networks and may reduce importation tariffs and fees, depending on customs process upon arrival. One rehabilitation professional describes how a cognitive aid was ordered:

> *I had to go through a company in South Africa and it took ages and then I realized that they also import into South Africa, so they probably didn't have it in stock. So, the next time when I needed more what I did was to ask a colleague in the States, and within two weeks I had what I wanted. (Direct service, government)*

Grey imports take place at a small-scale, often one client at a time, and may not come with warranties or services available if imported formally.

Constraints to increasing AT imports of foreign manufactured AT

As with local manufacturing, inadequate AT financing for products and services across all sectors was identified as the primary constraint to increasing AT imports in Southern Africa. Participants and other data sources also pointed to the high cost of imported AT as a major barrier to increasing the quantity, quality and range of AT products. A range of a supply chain inefficiencies were a primary reason for the high cost of imported products. These inefficiencies are discussed in the next subsection.

Some participants thought the high costs were partially explained by the limited range of low cost AT available on the global market. These participants reported that the majority of AT products were designed for high resourced countries and that research and development that focuses on appropriate AT for Southern Africa was almost non-existent. Another participant with knowledge about a broad range of AT available disagreed, stating that the range and quantity of AT appropriate for Southern Africa were sufficient on the global market but these items were difficult to obtain because of proximity and lack of awareness. They stated:

> *I personally feel like the sky is big enough for all the birds. There is enough AT, in fact there has been quite a lot of development in terms of AT to assist people. I don't think that is an issue - not having enough. It's more about how far away it is and how isolated are we from that point to where we are. These advancements tend to happen in developed countries as opposed to where we are, so they become farfetched…You don't expect the general population or most people to know of these things. Even the health care providers, even within OTs, because our training does not give us much in terms of devices. (Direct service, government)*

A review of a few AT supplier product catalogues show that there is an extensive range of AT types that suppliers offer, at least in South Africa, though most products appear to be higher end (Sensory Solutions 2019).

Facilitators to increase AT imports from foreign manufacturers

The primary channels for bringing appropriate AT into South Africa were well-established companies that specialize in AT products. As with local manufacturing, gradual and consistent increases in pubic AT budgets in South Africa have facilitated increases in the imported supply of AT. Some of these AT companies have worked in the AT industry for decades and have developed internal systems to forecast and manage product stocks as part of good business practice. Both the trusted relationships

with foreign manufacturers and well-established import processes allow them to be responsive to changes in demand.

> *An importing company needs to have the importing structure in place…You have a process and need to follow the process…For us we are doing this for years. Our processes work. (Direct service, for-profit)*

Larger AT companies who are purchasing directly from foreign manufacturers can offer lower prices as they operate higher up on the supply chain and may also be required to limit price mark-ups by the manufacturers.

One of these suppliers stated that they needed to have the financing capacity to purchase large quantities of AT to keep a rolling stock. Keeping a local stock reduces time required between order to delivery. In addition, AT orders and payments are often made in advance of receiving payments from customers or other funding sources.

> *The only challenge would be if I have a spike in demand…The manufacture will want my money upfront, so I need to be a company with a strong financial ability. We have. That's why when I buy something, I don't buy one of them…We have a rolling stock. (Direct service, for-profit)*

In Zimbabwe, a few examples were provided of international non-profits purchasing directly from foreign manufacturers. One non-profit was able to use foreign bank accounts to buy AT in bulk from foreign manufacturers. Within the challenging economic context of Zimbabwe, the ability to bypass unreliability local banks that have high charges for exchanging currency and making transactions is an advantage.

A summary of broad level facilitators for increasing imports of foreign made AT is provided in Table 5.2. Many of the underlying causes of high cost AT imports are explained in the next subsection on supply chain inefficiencies.

Table 5.2 Constraints and facilitators to increase AT imports of foreign manufactured AT

Constraints	**Facilitators**
Inadequate AT financing from all sectors	Gradual and consistent increases in AT budgets from all sectors (government, non-profit, for-profit)
High cost of AT due to supply chain inefficiencies	Procure from direct local buyers of AT including: • suppliers that specialize in AT, have well-developed importing processes and established relationships with foreign manufacturers • international non-profits that buy directly from foreign manufacturers

Supply chain inefficiencies for both locally made and imported AT made overseas

In the two previous subsections I characterized the two sources of AT, either AT that was locally made within Southern Africa, or made overseas and imported into Southern Africa. In this next subsection I describe numerous inefficiencies within the supply chain that impacts all AT products, both those made within and outside of the Southern African region.

Supply chain inefficiencies emerged as a main theme within the product supply component of the AT sector. This deep dive into the nature of supply chain inefficiencies helps explain a major constraint within the AT sector, namely that purchase price of AT in Southern Africa is unnecessarily high.

Products imported into South Africa or traded between Southern African countries are subject to numerous supply chain inefficiencies that increase the cost of AT. Supply chain inefficiencies are conceptualized as potential ways that resources are wasted along the pathway that products travel from manufacturers to end users. Sources of waste described in this subsection include duplicated roles along the supply chain, unfavourable trade policies, lack of bulk purchasing and the high cost of transporting goods across borders within the Southern Africa region.

While there are major differences in the supply characteristics of locally made versus foreign made AT, this is also somewhat a false division as locally made AT depends on materials, equipment and parts that are often manufactured overseas. Moreover, there are some products types that contain both locally made and foreign made components such as prosthetic limbs that imports a knee or foot component but fabricates the limb locally. Thus, supply chain inefficiencies greatly influence all AT supplied within Southern Africa.

Redundant intermediaries in the supply chain

The duplication of roles along the supply chain serve to increase AT product costs. Duplicated roles mean that multiple intermediaries (i.e., importers, buyers/sellers) serve the same purpose so do not add any value to the product while adding cost by buying and reselling the product. These redundant intermediaries may in fact reduce the value while they increase cost by creating more links in the supply chain between the manufacturers and end users. More links reduces the likelihood that end users will receive post-sale product related services (e.g., training, repair, replacement parts). Participants described these intermediaries with different labels. In Botswana ‘brief case supplier’ was used to describe a businessperson from the formal or informal sector that buys and sells a wide range of products to supply government tenders but does not have expertise in any particular industry. In Zimbabwe and South Africa, a similar role was identified for intermediaries, referred to as ‘third party vendors’, who only buy and sell products and do not provide additional services or product expertise. In the worse cases these intermediaries engage in profiteering by placing

exorbitant mark-ups on AT products. Participants identified the lack of regulations as one reason that redundant intermediaries can enter the AT market and operate freely. 'Redundant intermediaries' will be the term used to describe this role from here forward.

Lack of information about AT suppliers is another contributing factor to creating and sustaining redundant intermediaries. When piloting the AT-Info-Map project in Botswana it became evident that rehabilitation professionals within both the public and for-profit sectors were often not aware of which companies were purchasing AT directly from manufacturers within their country or the region. Without this awareness rehabilitation professionals would often purchase products from a redundant intermediary at a higher price. Likewise, ends users who were able to pay for AT out of pocket were not aware of the most direct point of purchase. The lack of publicly available information on AT suppliers was identified as a problem in the broader Southern African region and was one of the motivations for developing the AT-Info-Map project.

Indigenization and Black Economic Empowerment policies implemented by government can also add redundant intermediaries to the supply chain, thus increasing the overall cost of AT. A few participants described how these types of policies made purchasing directly from manufacturers at a more competitive price more difficult:

> *When we tendered last year in Botswana… we tendered say R10k per wheelchair, and the other company that was 100% Botswanan, not 55% like ours got the tender. They bought the chairs from us for 10k and sold them for 15k. So now the government is paying 15k for something they could have paid 10k, and there were no services. We offered 10k with services and they offered 15k for just the chair. (Leadership, for-profit)*

> *Let's go back to procurement – when government needs to buy that software [pointing to JAWS], they put that on tender. Now everyone who is listed as potential suppliers for government, which is 1000's of companies, they just look for what they can sell…'Oh, they need to the JAWS software'…this costs R11750, that's the retail price, the price I sell to you or government department….I receive 5 requests from third party companies…'please send me a quote for that [JAWS]'. So I am quoting them, those third party companies that know nothing in my field….The R11750 they pay for the software, they will sell it for R14k or R15k to government. Government receives the tender – mines for R11750 and R15k from third party but they have a better BE rating, they get the deal. (Direct service, for-profit)*

When these economic empowerment policies serve to add redundant intermediaries to the supply chain, particularly those that lack AT expertise, products can be issued without needed services such as assessments, follow up, maintenance and replacement.

It is important to note that both participants quoted above supported the intention of these empowerment policies and believed they were critical to help correct historic structural inequalities. However, the way these policies were applied in some cases were increasing AT cost and reducing value for end users.

Trade policies and processes

The cost of imported products upon entry can greatly exceed the foreign manufacturer's retail price due to cost of shipping, customs processing fees and tariffs. Fluctuating foreign exchange rates could also increase costs. The South African Rand has lost over half the value in comparison to the USD in the last 10 years thus doubling the cost of imported AT from abroad.

While some AT products are duty exempt in some countries, many products still incur duties. Mobility devices are more likely to be duty exempt where AT devices that are less common such as communication or low vision devices are less likely to be exempt. In discussion duty exemptions for mobility devices, one participant stated:

> *The good part is that governments in different countries that I have worked in, they have a system where if wheelchairs are coming in and follow the proper procedure, they are duty exempt because they know locally there is no capacity, no skill, no knowledge to make all those assistive devices, walking frames, crutches, prosthetic materials. (Direct service, non-profit)*

Raw materials needed to manufacture AT such as steel tubing for wheelchairs or foam for seating and positioning supports, and mainstream consumer products like sunscreen or IPADs are not exempt. A few participants mentioned that duties on ICTs such as accessible hardware were higher than other types of AT products. Duty exemptions can be applied consistently for certain categories of products (e.g., hearing aids) or be decided case by case. A local NGO in Zimbabwe must apply for duty exemptions for each AT order received.

> *We had to seek support from [name of international NGO] to provide a certificate of donation, saying 'after procurement these wheelchairs are now donated to the implementing partner', who applies for the rebate clearance, and that worked well. (Leadership, non-profit)*

Even when duties are exempt there can be several fees incurred during the importation process such as storage costs and brokering and processing charges. One participant estimated that imported prosthetics components cost 25% more because of duties and fees charged by multiple border clearing agents. Another participant commented on storage costs:

When the container gets to the inland, it will be shipped to logistics company and those companies will then charge you for storage. But you can ask them to waive a certain fee on the condition that you are also trying to help vulnerable people. (Direct service, non-profit)

Sole agents for foreign manufacturers of AT

Foreign manufacturers may only directly retail their products to a national or regional 'sole agent', meaning that they do not sell directly to other potential buyers in the region. Then the sole agents are responsible for retailing to other buyers in the country or Southern Africa region. Most sole agents, also called exclusive or preferred suppliers, are based in South Africa.

The pros of sole agent agreements mentioned by participants were that these agents receive training about products, often provide information and training to their clients and post-sales support including repair or replacement. The sole agent arrangement can be particularly beneficial when products require high level expertise and training. Manufacturers can also restrict the mark-up price as part of the business agreement with sole suppliers which prevents profiteering.

One con is that sole agents based in South Africa can increase product costs to buyers in surrounding countries. Sole agents can cover large regions like all of Southern and East Africa which means buyers across multiple countries must purchase through sole agents in South Africa instead of buying directly from manufacturers. If buyers outside of South Africa were able to buy directly, they could get a better price. If products are stocked and shipped by sole agents, other buyers also incur expenses related to crossing multiple national borders instead of just one.

Another potential downside mentioned is when a provider organization (e.g., for-profit clinic, public rehabilitation unit) serves as a sole agent for an AT manufacturing company as this agreement could influence clinical decisions. As expressed by one participant:

In South Africa we have exclusive suppliers for rehabilitation units and I am opposed to it. I think people should have choice. A newly disabled person should try 3, 4, 5, 10, many different wheelchairs and find the supplier that fits best for them. But we have a lot of rehab units that work on a preferred supplier basis…so they tend to push and bully people on to that product which is wrong. (Leadership, for-profit)

In this case, the sole agent arrangement is not only a potential supply chain inefficiency but reduces choice on behalf of direct service providers and end users.

Lack of bulk purchasing

Participants described how buyers who are importing AT products into Southern Africa rarely purchase AT in large quantities (bulk buying). Some bulk buying does take place in South Africa for

products that are off-the-shelf or generic such as bifocals, orthotics braces, basic crutches, walkers or hospital wheelchairs. Larger quantities may also be orders when select product categories (e.g., hearing aids) are financed at higher volumes in South African government tenders. Smaller orders may be necessary because products are highly specialized, customized, high-end or rarely required. However, it is more common that the lack of bulk buying is attributed to inadequate financing and lack of information on end user demand.

Lack of information on demand refers to inadequate data on current or projected demand for AT products. A few mechanisms to gauge AT demand were mentioned by participants but these were not consistently applied. For example, in South Africa every three or four years the ministry of health requests waitlists from provinces to determine how much more funding is needed to address unmet AT needs, though this amount is never fully funded. Companies that specialize in AT may develop inventory and sales tracking information systems than can be used to forecast demand.

Costly regional shipping

Moving products across borders within Southern Africa can be costly due to tariffs, inefficient border processing and high costs of land transport. As stated by one participant:

> *The accessibility into the other countries, South Africa's water posts, road freight, rail – these are disasters. I mean Gaborone is closer to us [Joberg] than Cape Town but it probably costs us five times as much to send a container of wheelchairs from Joberg to Gaborone as opposed to from Joberg to Cape Town.*
>
> *Researcher: Mainly because of import duties?*
>
> *No, the trucks get stuck at the border for 2-3 days, that costs money and they fold that into the quote. Getting the paperwork, getting it through the border, and Botswana is good compared to Zimbabwe. It costs more to bring a container from Joberg to Harare than from it would from China to Joberg. (Leadership, for-profit)*

Hypothetical illustration of supply chain inefficiencies

Evidence to demonstrate the extent of increased prices due to supply chain inefficiencies was hard to locate. One public procurement plan published by the Botswana Public Procurement and Asset Disposal Board (2016) reported a cost estimate of P600,000 (60,000 USD @ .10 exchange rate) for a Braillo 300 printer that retails for 23,000 USD (P230,000) from the manufacturer (Braillo 2018). This price difference of 37,000 USD is a 160% cost increase. The following Table (5.3) shows a hypothetical example to illustrate many of the supply chain inefficiencies described above, based on the Braillo 300 case.

Table 5.3 Hypothetical case of supply chain inefficiencies: Braillo 300

Supply chain steps	**(Increased cost) Purchase price in USD**	**Supply chain inefficiencies**
1. Manufacture sells one Braillo 300 printer to company A in South Africa	$23,000	Lack of bulk purchasing.
2. Shipping costs from US to South Africa	($2,000) $25,000	
3. Tariffs and border processing fees	($3,000) $28,000	Lack of duty exemptions. Border inefficiencies.
3. Buyer A sells to B, buyer B to C, buyer C to D in South Africa	($15,000) $43,000	Redundant intermediaries. Lack of price markup regulations.
4. Buyer D sells to buyer E based in Botswana	($5,000) $48,000	Indigenization policy. Lack of price markup regulations.
5. Shipping/tariffs to enter Botswana	($7,000) $55,000	Lack of AT duty exemptions. Costly regional shipping infrastructure. Border inefficiencies.
6. MOE purchases from company E	(+5,000) $60,000	Lack of price markup regulations.

Strategies to increase AT supply from the perspective of participants

This section on product supply covered how products are sourced (locally made or imported from overseas) and a range of supply chain inefficiencies. During interviews participants provided strategies on how to increase AT supply, either based on their experience of what they have seen work or what they anticipate would work.

There was agreement that increased AT financing from all sectors is needed for increasing both local manufacturing and importing of AT, including spare parts. The two categories of AT financing discussed were 1) direct funding for products and services and 2) investments made in AT businesses development and growth. A few participants recommended that government investments in starting and scaling up AT businesses needed to be combined with approaches to expand and reach markets for these products.

In South Africa the gradual increase in government budgets for AT over the past 20 years has proven particularly effective in increasing local manufacturing capacity of mobility devices. In countries surrounding South Africa where there is less public funding for AT, non-profits and for-profits play a larger role as buyers and providers of AT. Detailed descriptions of AT funding sources and challenges to increasing and improving AT funding are provided in Section 6.3 Financing.

There was lack of agreement as to the potential for local manufacturing or low-cost product innovations to address the large unmet need for AT in Southern Africa. The high cost of business start-up and AT production pose major barriers for increasing local manufacturing. In terms of

developing new low-cost products overseas or within Southern Africa, some participants were sceptical that these innovations would improve access as most access barriers relate to barriers within the AT system and are not due to lack of low-cost products available on the global market. Furthermore, participants described the process for getting new product innovations registered by government or medical aid sources as burdensome and lengthy.

A few recently launched global AT initiatives proport that developing new low-cost and appropriate AT products is needed to increase supply. Specifically, the Global Disability Innovation Hub (GDI) has established programs in accelerate product innovations in East Africa and aims to create similar innovations hubs in other regions (Global Disability Innovation Hub 2019); and the AT market shaping approaches aims to invest in research and development and accelerate innovation of appropriate and affordable AT (Savagea 2019). There are recent examples of AT product innovations such as the 3D printing of mobility devices (https://www.motivation.org.uk/changing-lives-with-3d-printing) and alternative and low cost designs for prosthetic components (http://www.nonspec.org/) that have potential to substantially reduce costs. As observed, having people with disabilities involved in the research and development of new low-cost products within Southern Africa and was met with enthusiasm among the DPO community (Southern Africa Federation of the Disabled 2017).

While increasing funding for AT, products that are currently available or new innovations, has potential to stimulate both the imported and locally made AT markets, it will not address supply chain inefficiencies (e.g., redundant intermediaries) or ensure sustained use. A few strategies were identified by participants that reduce product costs and/or increase sustained use.

- Prioritizing 'direct and full-service suppliers': One approach to make supply chains more efficient is for major buyers of AT from public, for-profit and non-profit sectors to purchase AT from direct and full-service suppliers. These suppliers buy directly from manufacturers or are manufactures themselves, have AT expertise and offer post-sale services (i.e., training, repair, replacement). If procurement policies and practices prioritize direct and full-services suppliers, redundant intermediaries would be reduced within the supply chain. Furthermore, these suppliers are likely to increase sustained use of AT as they offer post-sale services. A few suppliers who specialize in AT reported attending international trade shows and conferences to stay informed about advancements in the global AT industry including new lower cost product innovations. Direct and full-service suppliers are most often for-profit businesses but could also be international or local non-profits who have developed AT expertise and direct supply channels.
- Develop and apply industry regulations: Regulations could serve to restrict market entry and behaviour of intermediaries for AT imported and regionally traded along the supply chain.

For example, limiting price mark-ups would help address supply chain inefficiencies. Trade and industry policies that effect AT supply will be covered in detail in Section 6.5 Policies.

- Assembly model: A few non-profit and for-profit organizations import AT packages of parts and materials that are ready for local assembly. Local partners are then trained in assembly and modifications to match end user needs. This assembly model serves to create employment opportunities and build local capacity for post-sale services. However, unfinished products are often subject to import duties and dependent on donor funding. A stated by a participant in Zimbabwe:

  [Name of local workshop] is primarily focused on refurbishment and assembly but assembly has limitations because until they can get a donor to bring in these wheelchairs and engages them, they have nothing to assemble. (Leadership, non-profit)

- Refurbishment and reuse: AT products that are no longer needed by end users can be refurbished and reused. This strategy avoids many of the supply chain inefficiencies of bringing new products into the region, though often depends on availability of imported spare parts.
  - An online exchange to facilitate reuse of used ICT products set up by a supplier.
  - A refurbishment and reuse program for mobility devices established by a public sector rehabilitation professional in South Africa. This program was developed out of necessity due to the severity limited and inconsistent supply of devices provided through the public health system. The program was partially supported by philanthropic funding and included community outreach, trained repair personnel and a client/product tracking database. One component of this reuse effort was a strong network of Community Health Workers (CHWs) who help identify AT in the community that are no longer in use or needing repair. About 150 CHWs meet at the central hospital monthly and part of that meeting includes providing updates on the status of clients with AT. For example, if a wheelchair user who had a stroke passes away, the CHW will inform the reuse program so they device can be picked up and refurbished. Details of this program provided by an interview participant include:

    We recycle at our hospital, whatever device comes back that can be reused is reused…We make the patient sign a contract as well as we issue the chair, 'should you no longer need this chair, you should please bring it back because we have a very small budget', and people quite good about it. They don't bring it back when they live really far and it would cost them money to put the wheelchair on a taxi to bring it in, but that is when the CHW tell us and we so put it on the collection list…It's a great system, 60% of all the wheelchairs we issue are second hand

refurbished chairs so we are saving 60% of the budget…I have two wheelchair repairment who are on stipend by DOH which is amazing and I think this should be put in place, standard across the board nationally. Everyone needs a wheelchair repairer. (Direct service, government)

Synopsis of product supply

The majority of AT available in the region is imported through or made within South Africa. Consistent increases in government AT spending in South Africa has facilitated the scaling up of local manufacturing in mobility devices. The South African market also relies on AT products and parts that are manufactured abroad and imported. Outside of South Africa, non-profit or for-profit actors play a larger role than government in purchasing and providing AT. Particularly in countries with minimal government funding such as Malawi, the majority of AT is made available through international and local non-profits.

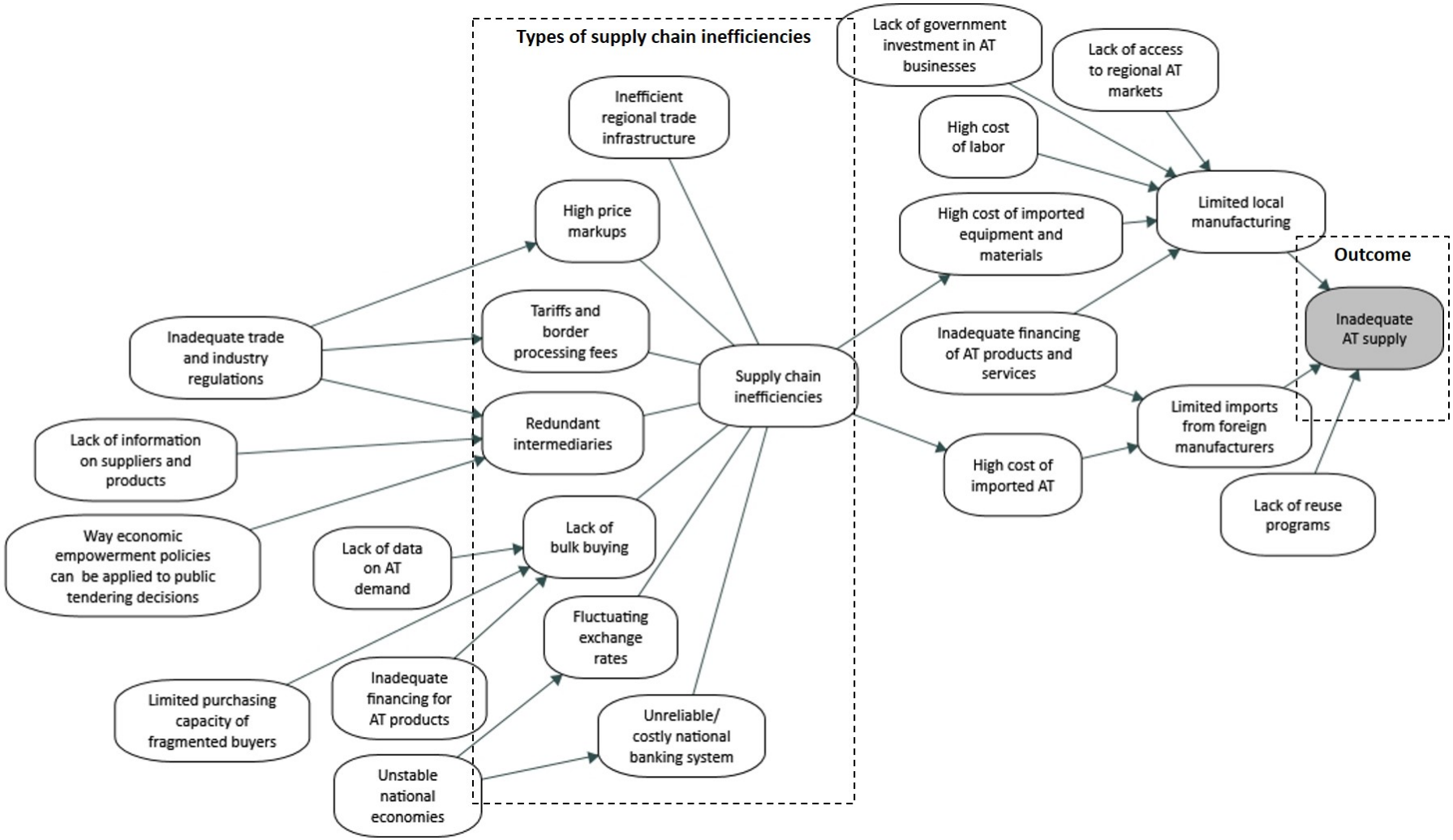
A range of supply chain inefficiencies increase the cost of both imported AT from overseas and locally manufactured or assembled AT. For example, it is likely that one hearing aid could travel multiple continents before reaching the end user in Southern Africa, and the path from origination (manufacturing) to provision can involve several redundant intermediaries. Some supply chain inefficiencies are not specific to the AT sector but are due to broader economic and infrastructural barriers (e.g., fluctuating exchange rates, capacity of national banking systems).

Increasing product supply through of combination of imports and locally made products face several constraints (see Figure 5.4). The primary constraint is inadequate financing for both products and related services. Combining the lack of financing with the unnecessarily high cost of AT leads to inadequate supply. The lack of reuse programs is another contributing factor to inadequate supply.

Finally, the high cost of spare parts combined with inadequate post-sale services, decreases the products lifespan. This is one of the greatest sources of waste within the current AT sector in Southern Africa as the value (i.e., full product lifespan for end users) of the costly process of supplying AT is not realized.

Understanding supply chain inefficiencies is critical to advancing knowledge about AT access in Southern Africa and other resource limited areas. All countries in Southern Africa except South Africa must depend on AT imports due to lack of capacity to manufacture AT locally. Even if substantial investments are made to develop the local design and production of AT, most parts and materials will most likely be imported from outside the region and thus be subject to costly supply chain inefficiencies.

Figure 5.4 Product supply: Outcome and contributing factors



5.4 BRIEF SUMMARY OF THE END USER AND PRODUCT SUPPLY COMPONENTS OF THE AT SECTOR

In Chapter 5 the experience of end users (Section 5.2) pointed to insufficient funding as a key underlying factor that resulted in lack of access, long wait time, lack of sustained use and the receipt of inappropriate devices. Inefficiencies in the design of the procurement and provision system were also found to reduce access and increasing wait time.

The examination of the inadequate supply of AT (Section 5.3) encompassed global, transnational and national levels. Lack of financing combined with supply chain inefficiencies resulted in the inadequate supply of both locally manufactured and AT imported from manufacturers overseas. Supply chain inefficiencies such lack of bulk buying, redundant intermediaries, regional trade infrastructure, and fluctuating exchange rates increased the cost of AT for all buyers. The lack of reuse programs was also identified as a contributing factor to the inadequate supply of AT.

Product lifespans are shortened due to lack of repair and replacement services, which lead to lack of sustained use by end users. This problem may emerge as a major cause of wasted resources within the AT sector. Given the minimal financing available and high cost of AT due to supply chain inefficiencies, increasing product lifespans is likely a cost-effective strategy to help meet demand.

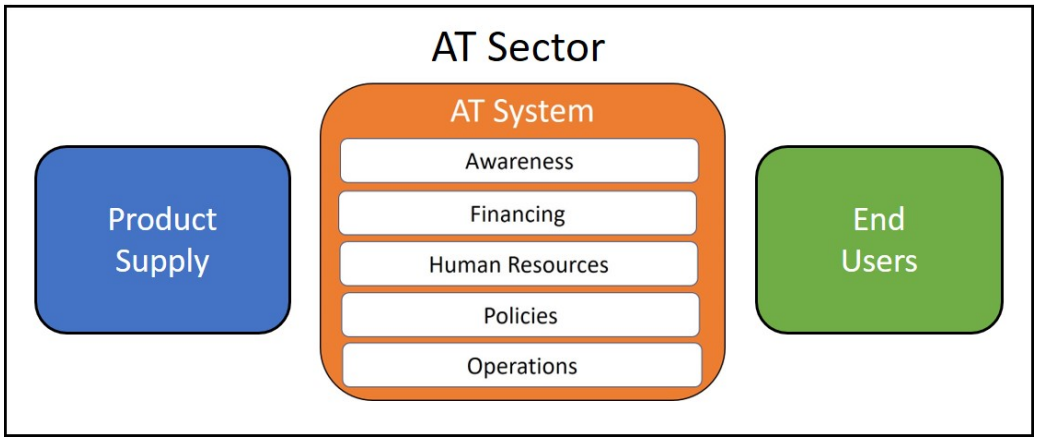
The low prioritization of AT emerged as a root cause of inadequate financing and many subsequent constraints when examining both the end user and product supply components of the AT sector. Lack of AT financing includes both funding for products and services and lack of investment in AT business development. Further explanation of the constraints identified in Figures 5.3 and 5.4 and details about how some of these constraints operate will be provided in Chapter 6. The five building blocks of the AT procurement and provision system: awareness (6.2), financing (6.3), human resources (6.4), policies (6.5) and operations (6.6) will be explored in Chapter 6.

CHAPTER 6: AT PROCUREMENT AND PROVISION SYSTEM

6.1 INTRODUCTION

In Chapter 5, end user experiences (5.2) and AT product supply sources, actors and supply chain characteristics (5.3) were described. The AT sector component that links end users to AT products will be covered in this chapter, organized into the five AT procurement and provision system building blocks (abbreviated as AT system) (see Figure 6.1). Note that Figure 6.1 is the same as Figure 5.1.

Figure 6.1 Three components of the AT sector and five building blocks of the AT system



The AT system that connects user needs with product supply is the most complex and problematic component of the AT sector. The five components that will be covered in this chapter include: awareness (6.2), financing (6.3), human resources (6.4), policies (6.5) and operations (6.6.). Within these building blocks there are multitude of actors, structures, resources and/or processes that facilitate or impede access to AT.

The key characteristics of unmet end user needs described in Section 5.2 included lack of access, long wait times, receipt of inappropriate AT and lack of sustained use. An explanation of the roots causes of unmet AT user needs will be found in examining the five interrelated building blocks of the AT system. The aim of this exploration is to identify the key bottlenecks within the AT system and associated leverage points that will serve to strengthen the overall AT sector in Southern Africa.

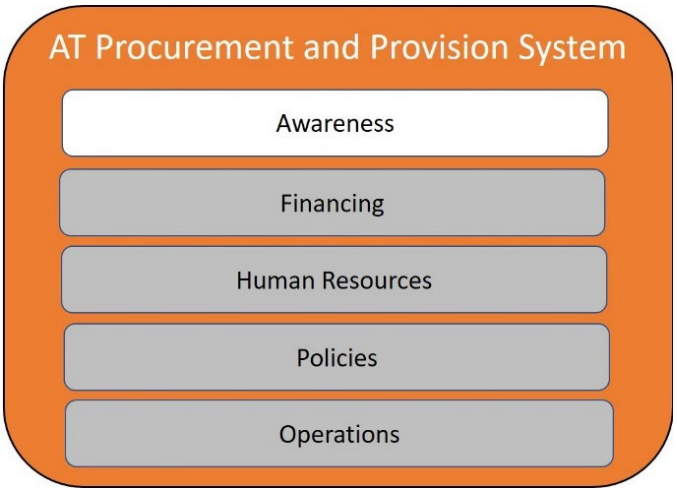
The ordering of the five sections presented in this chapter aligns with the prominence of these building blocks from the data. The first two themes, awareness (6.2) and financing (6.3), first came to mind when participants were asked, 'What are the primary bottlenecks to increasing AT access within Southern Africa?'. Lack of AT awareness and information emerged as major theme and primary factor to explain weaknesses within three other building blocks (i.e., financing, policies, human resources). Financing captures AT funding mechanisms for AT products and services within

for-profit, government and non-profits sectors. The next section, human resources (6.4) was usually described in relation to inadequate funding. This section described gaps in AT direct service personnel and strategies for increasing the workforce capacity. Policies (6.5) includes a broad range of international, transnational and national policies that shape product supply, procurement and provision. While different types of policies were mentioned by nearly all participants, the AT policy section relies more heavily on secondary sources than the other sections. Participants most often spoke about policies broadly (e.g., AT regulations are needed to ensure products are appropriate) but provided few specific details about existing AT policies and how those policies are developed, implemented or enforced. The final and shortest section, operations (6.6) covers some of the intricacies of AT procurement and provision day to day processes.

6.2 AWARENESS

Inadequate AT awareness is a major and pervasive barrier to increasing AT access in Southern Africa, experienced across all audiences and regions. In this section six different types of gaps in awareness are described. For the purpose of this study, awareness encompasses basic familiarly to knowledge of AT-related facts and evidence. For example, familiarity or basic understanding (e.g. 'I am aware that technology is available that enlarges printed text so people with low vision can read'), knowledge of AT-related facts (e.g., 'About 300,000 people are in need of prosthetics in my country') and evidence (e.g., 'People who have access to AT are twice as likely to find employment than those without AT') are all considered types of awareness. Clinical and technical AT expertise, such as training and professional skills needed to provide appropriate AT are covered under Human resources (6.4). Figure 6.2 highlights the awareness building block within the AT procurement and provision system.

Figure 6.2 AT procurement and provision system: Awareness building block



The discussion of the awareness building block below is organized into four subsections 1) low prioritization of AT, 2) information barriers to obtaining AT, 3) lack of information systems, resources and evidence and 4) strategies to address identified gaps from the perspective of interview participants.

Low prioritization of AT

Awareness about *what is possible, the extent of AT need* and *value of AT* are all critical to elevating the priority of AT among all audiences such as health care professionals, educators, employers, general public and those who influence policy and funding decisions. These three types of awareness gaps are described below.

AT awareness gap: What is possible

Interviews and other data sources show that there was limited general awareness about *what is possible*, specifically about the range of product types that exist and diverse range of disabilities and functional limitations that could benefit from different types of AT. As expressed by an industry supplier when asked about the major challenges to increasing AT access:

> *One of the primary ones is lack of information. People don't know what they need, they don't know what is possible so they don't ask for it, so lack of demand based on ignorance. (Leadership, for-profit)*

Another participant spoke to the lack of awareness about the range of AT:

> *The understanding of AT is narrow. AT is wheelchairs and crutches so that covers a small population so that becomes a problem of a minority. If people are using AT understand, e.g. you are using spectacles, so you are using AT, you have difficulty writing so you need to use AT, you use a hearing aid that is AT. So, there is lack of understanding of the scope of AT. (Direct service, government)*

Most participants described this lack of familiarity, *what is possible*, when referencing end users or the general public though a few examples of providers and suppliers were also provided. One participant described academic programs for rehabilitation professionals (i.e., occupational and physical therapists) that did not include information on the range of AT possible.

> *I feel like the training we get as occupational therapists in terms of AT is not sufficient to meet the demands out there. AT is bigger and it is only when I started to look at AT certifications like the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA), that is when I realized that this field [AT] is big. (Direct service, government)*

The lack of AT familiarity was most pronounced for non-mobility types of AT. As observed through the implementation of the AT-Info-Map project, stakeholders would most commonly mention wheelchairs when discussing AT during meetings and trainings. Other types of mobility devices including crutches, walkers and prosthetics and hearings aids came to mind when discussing AT but not as often as wheelchairs. The broad range of technologies that address needs of daily living, vision, intellectual and communication were rarely mentioned and thus educating project stakeholders about the broad range of AT became a perquisite strategy of the project. In response to this gap, a detailed training manual that included descriptions and product photos for 17 categories of AT was developed as part of the AT-Info-Map project (Southern Africa Federation of the Disabled 2018).

Similarly, representatives from two AT companies that provide non-mobility devices described educational activities developed in response to lack of basic awareness about what was possible for

people with visual and communication limitations. A provider of communication AT explains one reason why increasing awareness was important for their company:

> *People do not understand a disability that is not physical. (Direct service, for-profit)*

The emphasis on mobility types of AT is supported by the findings presented in Chapter 4 on sub-study 2 (i.e., people with mobility limitations are more likely to access AT than non-mobility disabilities) and is a reoccurring theme across other building blocks that will be discussed in other building blocks covered in this chapter.

AT awareness gap: Extent of AT need

Another gap is about the *extent of AT need,* meaning how many people within a given area require some type of AT. Some participants made rough quantitative estimations (e.g., 300,000 need prosthetics in country X, less than half are receiving AT they need regionally) and others used descriptors of the magnitude of unmet need (e.g. people in the community who need AT are in abundance). A few participants also reported that governments and other stakeholders vastly underestimate the number of people who need AT because they are not aware of how many people have disabilities and are not familiar with the range of AT possible. As stated by one participant:

> *There is not an understanding of what rehab is and why it is needed and there is a widespread perception that there are few people with disabilities because they don't see them because they don't have wheelchairs. When I have spoken with officials at district and provincial levels, they say we really don't have people with disabilities, it's not a problem. It's a lack of awareness. (Direct service, government)*

Another participant expressed frustration when describing a conversation with a government official from a smaller Southern African country:

> *'We only have 149 people needing wheelchairs in our country'. That is what they told us. That is what they base their tenders on. Seriously? (Direct service, for-profit)*

Waiting lists at hospitals and clinics have been used to help determine the level of unmet needs for some types of AT but these lists are not consistently maintained and only capture people who have been able to access health services to make a request. One participant described the process of trying to compile waiting list data from across South Africa:

> *We have no idea about waiting lists. I am trying to gather that [waiting lists] and I am literally phoning each hospital in South Africa to try and get that info. Some departments collect it routinely and others don't, so trying to come up with a national backlog is virtually impossible. (Direct service, government)*

Participants reported that data collection tools and information systems that quantify and characterize AT needs are lacking which contributes to: 1) inadequate financing because budgetary decision are made without evidence, 2) supply chain inefficiencies, specifically that bulk purchasing of AT requires information on demand and 3) the misperception that the market demand for AT is low which can inhibit investment in the AT market.

Stigma and discrimination also reduce the public visibility of people with disabilities which contributes to the perception that the need for AT is minimal. Examples were described during the AT-Info-Map discussions and by interview participants of people with disabilities who did not leave their homes because they and/or their families experienced discrimination.

AT awareness gap: Value of AT

The final awareness gap linked to the low prioritization of AT is the *value of AT* which encompasses benefits to end users, households and society. Benefits for the end user (i.e., improved functioning, independence and participation) can result in economic and social benefits to the household and society. A few interview participants stated that addressing this gap was critical to making an economic case for increasing AT access.

> *There needs to be more research and evidence on the value of AT and the drain on society when people don't have AT. (Direct service, non-profit)*

When discussing why medical aid (private health insurance) does not cover most types of AT, another participant stated:

> *There is some work to be done there so show medical aid how valuable it [AT] would be and come on board because they have money…I see that it is a numbers thing, they say 'I paid this guy for 3 years to sit at home, isn't there a way I can put him back in the work place?'…I am sure it is worth it, money wise and for the individual because AT does not fix my eyes but it will enable me to do something - to work or to study – and all of that for one soft cost. (Direct service, for-profit)*

The GATE Research Group identified this type of evidence as 'Effects, costs and economic impact of assistive technology', further stating that 'Such evidence is important to motivate countries to develop or improve policies and systems for the provision of assistive products' (WHO 2017a). From an industry perspective, market shaping initiatives aim to demonstrate an investment case (e.g., return on investment) for supplying appropriate wheelchairs and hearing aids (ATscale Global Partnership for Assistive Technology 2019, Savagea 2019).

A few participants described how the value placed on AT is in competition with other health and educational priorities within the broader economic context instead of seeing AT as part of addressing these other priorities. For example, AT may be perceived as 'non-essential' in comparison

with other health products such as antiretrovirals (ARVs) or vaccines. One participant described the attitude expressed by department of health and treasury officials:

> *'People don't need wheelchairs, wheelchairs are a luxury compared to ARVs', that kind of thing. Never mind that some people on ARVs can't access medication because they are disabled and don't have a wheelchair. (Direct service, government)*

Another participant described the influence of the economic crisis in Zimbabwe on valuing and prioritizing select types of AT:

> *When the economy went bad certain products became luxuries. When people think of function they think of a wheelchair, they think of crutches. So other things become luxuries like having a writing aid, so you will be able to write. And what makes them become even more luxurious is the cost to you to be able to get those things to the client. For instance, for children with perceptual impairments and difficulties with writing and you want to order raised line paper so they can write in a straight line. First of all, you don't find those things locally or regionally, close by. Last time I ordered from the states, a friend had to buy for me and send through to me. It came months later…the price is going to be high, and someone [client] is like 'it's good enough, I am surviving'. It's not that people do not appreciate these things but they become low in the priority order because people are dealing with very severe issues. When the economy is bad, it becomes an issue of life and death. (Direct service, government)*

Information barriers to obtaining appropriate AT

This subsection covers three additional awareness gaps that limit procuring and accessing available and appropriate AT products and services.

AT awareness gap: How to obtain AT

Buyers of AT from all sectors and end users face navigational challenges in trying to purchase and/or access appropriate AT. As stated in the previous chapter (Section 5.3, Product supply), a few participants reported that there was lack of information about suppliers of AT which made it difficult for buyers to locate the most appropriate and affordable AT products. This gap was a motivation for creating the AT-Info-Map information system (app and database) that mapped the geographical location of AT suppliers and providers across ten countries in Southern Africa. At an AT-Info-Map meeting a representative from a local non-profit that served students with visual impairments commented on the potential value of the AT-Info-Map data:

All that we are aware of is that most of the AT are imported from abroad, but we currently do not have much information about which suppliers are available and where they exist here, so this app will provide us with more options as an institution. (Direct service, non-profit)

Identifying the entry points of AT access for end users and their family members, meaning where to start, proved to be too complex to implement as part of the AT-Info-Map project. There was a wide range of organizations from public, for-profit and non-profit sectors that provided select types of AT, often with differing eligibility criteria for recipients. For example, a person injured on the job in Zimbabwe will access AT through a public worker's compensation rehabilitation facility while another person who requires the same type of AT and is covered by medical aid would receive AT from a for-profit hospital/clinic. Likewise, local non-profits may serve narrow subpopulations with select types of AT provided (e.g., hearing aids for children). The fragmentation of AT provision among many organizations increases the complexity of information end users need to understand how to gain AT access. Another complexity is that many types of AT require prescriptions from AT professionals so cannot be accessed directly from suppliers by end users.

Information of how to access AT also needs to be timely. There was one example of delayed access due to untimely dissemination of instructions to higher education students who are trying to access AT. To receive AT students must first have a certified professional assessment the specifies the type of AT required. Then they can apply for the National Student Financial Aid Scheme bursary for AT (National Student Financial Aid Scheme). The duration between applying for the receiving AT can take many months to a year and new students are rarely informed about how the application process works before they begin their studies. This can result in students not receiving the required AT until the 2nd or even 3rd year of study. One for-profit supplier stated that it was the responsibility of the higher educational institutions to inform students with disabilities that they should apply for the AT bursary as soon as they are accepted. Currently, students are not informed until classes begin which is too late.

AT awareness gap: Why access AT from an end user's perspective

Even when end users know how to access available AT or related services, they may not be motivated to seek access. End users may not understand or believe that they could benefit functionally and in terms of increased participation (e.g., accessing education). There may also be scepticism or even strong distrust of foreign technologies, and cultural beliefs about disability that limit adoption of AT products. As two participants described:

We travel a lot around South Africa…What I have seen is the culture, peoples' beliefs – some might have the funds but because of their culture they do not believe that 'my child can use a device to communicate. I rather wait for a time when my child gains speech on their own one day'. (Direct service, for-profit)

[Referencing colleague] has been doing community-based rehabilitation (CBR[9]) for 20 years and she said, 'Some people in the rural areas are afraid to use their assistive devices because the ancestors may be angry with them for doing something rather than waiting for ancestors to heal the person with disabilities. (Direct service, government)

The perception that people with disabilities have limited capabilities and/or fated to be dependent of family members or charity services also undermine motivation to access AT.

AT awareness gap: What is appropriate AT

As expected, the lack of awareness about appropriate AT was identified as a contributing factor to receiving inappropriate AT products in Chapter 5 (Figures 5.3 and 5.4). Examples of purchasing inappropriate devices involved actors within all three sectors, public, for-profit, non-profit, as well as end users. These purchasing decisions are often solely based on price and cheaper products are less likely to be appropriate for the end user or the environment.

A few participants described efforts to increase awareness about appropriate AT among the global development community and government officials in South Africa. As stated by one provider:

There are still – through particularly faith-based organizations, the rotaries, the lions, very often those similar to the international charity-model of wheelchair - have big donations coming in. That [inappropriate donations] was a big problem 10-15 years ago but as more awareness was created, more training was done, more advocacy was done, more and more organizations – the schools, the department of education, the hospitals – understood the need for proper equipment [AT]. So, if there was talk of donors coming in, they would ask them to purchase from local companies or please give us the funds rather than devices…If it is an inappropriate device like the plastic garden chair, they may be accepted but are handed out as shower chairs or transport chairs. Sometimes I have experienced where organizations will call and say 'we've been on the phone all morning and nobody wants our wheelchairs'. They are not interested because it doesn't meet the needs. That is actually becoming the norm. (Direct service, for-profit)

[9] Community-based rehabilitation (CBR) is an approach that addresses the rights and needs to people with disabilities in resource-constrained areas, and often includes the provision of AT. CBR programs are found across the globe and often include rehabilitation services and AT (https://www.who.int/disabilities/cbr/en/).

This topic, lack of awareness about appropriate AT, emerges again under the four remaining building blocks covered in this chapter: financing, human resources, policies and operations.

Inadequate AT information systems, resources and evidence

Participants reported that AT information systems, resources and evidence were a major contributing factor to many of the awareness gaps identified in Southern Africa. Data is needed to determine the *extent of AT need* and *value of AT*. Information resources are required to increase awareness about *what type of AT are possible*, facilitate product procurement and provision by informing intermediaries and end users of where and *how to obtain AT* and for operational purposes such as tracking product inventory.

Existing AT information systems and resources

The AT information systems identified through this study were local or national and based in South Africa, with fewer operating at a transnational or international level. Table 6.1 is not exhaustive but is illustrates different types of AT resources currently available.

Table 6.1 Examples of types of AT information systems

Type of information system/resource	**Examples**
Small-scale information systems implemented by one organization or individual.	Local supplier sales tracking system: One for-profit supplier that supplies a consistent range of AT products year to year, tracks sales to forecast demand.
	Public reuse program database: A direct service provider developed a database to facilitate the reuse of mobility devices. The information was used to identify users who needed AT, match users with refurbished products, and to inform future AT budgets.
National system managed by the South Africa government.	Health system wheelchair waitlists: Waitlists were inconsistently collected by government health facilities and lack a centralized data system, making it difficult to aggregate data to inform AT budget decisions.
	MOH national accounting system: This system tracks public expenditures but only contains a few line items for AT products. Thus, there is no way to track the quantity of different types of AT provided and costs.
	Higher education bursary supplier list: The AT bursary for higher education students with disabilities includes a list of devices, allowable costs and preferred suppliers (National Student Financial Aid Scheme).
Transnational AT information system.	Supplier directory: The AT-Info-Map is the first attempt to develop a transnational AT information system for identifying and selecting suppliers across ten countries in Southern Africa. As described in Box 2.1, this system is broadly inclusive so there is no guarantee the suppliers or products adhere to quality product and services standards.
International supplier and product lists.[10]	NGO assistive product list: This resource developed by UNICEF includes a broad range of AT products, brands, features, service standards and prices; and targets NGOs and governments. The stated aim: *'This overview is a resource for procurement practitioners in development and humanitarian organizations and for government policymakers who support the planning, procurement and provisioning of assistive products.' (UNICEF 2018)*
	International partnership database of preferred suppliers: The Agency for Prevention of Blindness (IAPB) database has a preferred list of suppliers. The IAPB website indicates that the list of preferred suppliers was compiled by experts, many with experience in resource-constrained settings.
	Supplier product catalogues: Manufacturers and/or suppliers that retail globally have detailed product lists and specifications in catalogues.

Participants described all these systems and resources as inadequate as they only address a subset of AT, target a specific audience and/or operate within one sector or organization.

[10] The WHO GATE Assistive Product List was excluded from list as it is designed to be a global policy shaping instrument so is included in the policies section (6.5).

The participant that mentioned the IAPB list stated that they were not aware of a similar global resource that focused on AT that was designed for the global development actors:

> *I am not sure if there is an international database, coordinated by international organizations, who are supporting the procurement of devices internationally. I haven't come across that. I am thinking along those lines because we have a similar database for suppliers of drugs, consumables and equipment. For example, for the eyes, The IAPB has a preferred list of suppliers, where suppliers can register to become part of that database. So, it is easier when I need equipment because they have a list of suppliers with credible supplies. This has not been the case with assistive devices. (Leadership, non-profit)*

The lack of centralized and uniform AT information systems and resources hinder growth and reflect the fragmentation within the AT sector. For example, the lack of centralized resources that compile basic AT product information such as price and product features for a broad range of AT types and across multiple suppliers, makes it difficult for buyers within government, for-profits and non-profits to compare options and select the most appropriate and cost-effective products.

Lack of existing evidence

Research is needed to address many of the awareness gaps, most specifically to determine the *value of AT*. As found in sub-study 1 (Chapter 3), existing AT research in Southern Africa is sparse and generally fragmented by AT type. The Living Conditions Studies that have been conducted in nine countries in Southern Africa provide the most comprehensive snapshots of unmet AT need. While study reports have been given to key decision-makers within each country, it is not known if findings have been used to inform funding or procurement decisions at the national level.

Strategies to address AT awareness gaps from the perspective of participants

Examples of existing strategies listed below in Table 6.2 were initiated by non-profits, for-profit AT suppliers and individual government rehabilitation professionals.

Table 6.2 Existing awareness raising strategies by sector

Sector	Awareness raising strategies
Non-profit	SAFOD coordinated AT awareness raising events in four countries in Southern Africa to educate participants about the range of AT possible, unmet needs and discuss advocacy strategies. Stakeholders included representatives from ministries of health and education, AT suppliers, DPOs, educational institutions, and industry and government rehabilitation professionals.
For-profit	AT professionals from for-profit AT suppliers cultivate AT awareness with individual clients within communities. Activities are often in-person to provide hands on demonstrations of AT. When there was distrust of 'foreign' technologies, more common in rural areas, awareness raising efforts required multiple interactions over time. Onsite product demonstrations to employers, educators and at exhibitions, and national AT awareness raising campaigns were also implemented to increase general awareness and demonstrate the uses and benefits of AT.
Government	Government rehabilitation professionals made presentations to select officials within the ministry of health who were involved in budgeting for rehabilitation and AT. The presentation covered an orientation to rehabilitation and AT, and the value of these products and services to end users.

Strategies for increasing awareness were implemented by one organization or individual and thus were limited in reach. Reaching a wider audience and sustaining these awareness raising activities overtime was not affordable for for-profit suppliers or non-profits. A few participants felt strongly that the government should be the primary funder of board-based AT awareness raising efforts. When one participant was asked what would help their AT company grow, they responded:

> *If we could have the government fully on board.*
>
> *Researcher: What does that mean?*
>
> *Meaning government gives us more opportunities to train, opportunities to provide devices and materials to any organization that has a need. That will make a difference. Right now, people have to find out for themselves about AT, some do not even know what it is but if this were to be part of education policy that is rolled out to every school then more people would be aware of what is AT and what they can do with it. Right now, we don't have knowledge. (Direct service, for-profit)*

Participants also identified specific groups that should be targeted to increase understanding of *what is possible* (range of AT, potential beneficiaries), *extent of AT need* and *value or AT*. One rehabilitation professional stated that relevant government officials should be a target audience to raise awareness.

> *Another thing I would change is that understanding of rehabilitation at all levels. It needs to be understood by people in treasury and the department of health. They need to know that this is a substantial proportion of our population, it's not*

a minority, it's not people who are basically useless…'Oh they get grants so they are ok, they don't need anything else'. (Direct service, government)

Another group mentioned were rehabilitation professionals. One participant recommended that postgraduate curriculum should orient rehabilitation professions (OT, PT, SLP, audiologists) to a wide range of AT and AT skills that were contextually relevant, particularly to those living in rural communities. Lack of AT knowledge and skills among direct service providers are covered in greater detail in Section 6.4 Human resources.

Synopsis of awareness building block

As expected, the level of AT awareness was perceived to be higher in South Africa than in surrounding countries and most of the existing information resources and awareness raising interventions took place in South Africa. Specific types of information needed to address gaps are listed in Table 6.3.

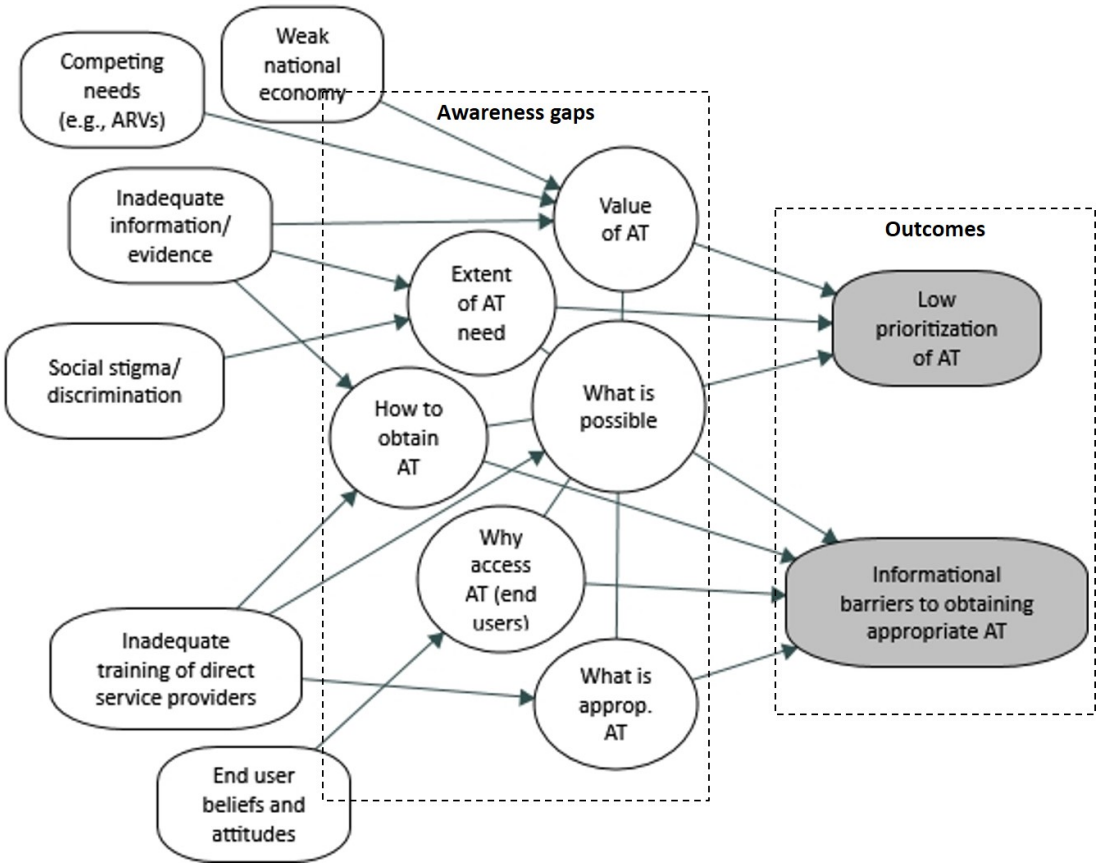
Table 6.3 Information needed to address awareness gaps

Awareness gaps	**Description of needed information**
What is possible	• Range of AT types • Potential beneficiaries of AT (disabilities, aging, chronic conditions, injured)
Extent of AT need	• Number of individuals who currently need one or more AT products and related services by types of AT and geographical region • Estimated number of potential AT end users to inform future projections (people with disabilities, aging, injured, etc.)
Value of AT	• Cost benefit of improving functions and increasing participation of AT end users (e.g., education, employment, poverty reduction). Example: Cost savings to medial aid companies when covering AT/rehabilitation that prevents need for more invasive treatments (e.g., surgical)
How to obtain AT	• Pathway for end users to access AT based on end user profile (e.g. veteran, higher education student) • Preferred AT suppliers, products and direct service providers • Product comparison information (product specifications, price)
Why access AT	• Benefits to end users and households – functional and increased participation (e.g., education, employment) • Addressing beliefs that limit access
What is appropriate AT	• Potential harm of inappropriate devices • Preferred AT suppliers, products and direct service providers that offer appropriate options

Figure 6.3 below shows the contributing factors to these six identified gaps that are within the box labelled awareness gaps. The two brad constraints in the AT system that result from these gaps are the right side of the figure depicted by shaded rectangles are the *low prioritization of AT* and *barriers to obtaining appropriate AT*. The left side includes the factors that contribute to the identified gaps.

What is possible is placed centrally and linked to the other five gaps. Addressing this gap, *what is possible*, is a prerequisite to the five other gaps. For example, an end user must know that a type of AT is possible that would address their needs before trying to access that AT. All six gaps impede strengthening of the AT sector.

Figure 6.3 Awareness building block: Outcomes and contributing factors



Existing awareness raising efforts are small-scale and often led by one individual or organization. Information systems were inadequate, lacked uniformity and were fragmented across a variety of organization from local to global levels. Well-designed, comprehensive and sustainable awareness raising activities depend on government support. Thus, current these efforts are piecemeal within limited and inconsistent reach.

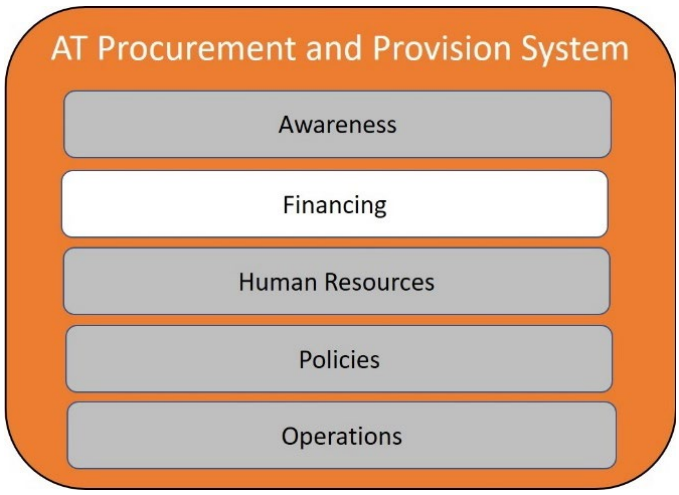
6.3 FINANCING

When asked 'What are the major bottlenecks to increasing access to AT?' nearly all participants mentioned the lack of funding for AT products and services. The current level of AT funding is drastically inadequate in all of Southern Africa and funding mechanisms are fragmented across multiple government ministries/departments, non-profits and for-profits. Only a small percentage of end users and families can pay out of pocket.

This section covers the financing building block within the AT system (Figure 6.4) and is organised by three major groups of AT funding sources: government, non-profit and medical aid. Governments and non-profits were identified as the primary AT funders in most of Southern Africa and thus these two categories are described in greater detail. Existing and recommended strategies for increasing funding and associated challenges are described for all three groups of AT funding.

This section is primarily focused on direct AT financing for products and services, with fewer examples of funding invested in developing the broader AT system (e.g., policies) or industry (e.g. research and development of new products).

Figure 6.4 AT procurement and provision system: Financing building block



Government AT financing

The process for making AT funding decisions differs by government funding source, by country and even facility (e.g., hospital). In this section the primary government funding sources for AT are described, highlighting the pros and cons of each source as described by participants.

The ministries of health (MOH) was discussed most frequently among interview participants. Other government departments discussed included ministries of education (MOE), ministries of social development/welfare/disability, road accident fund (RAF), department of veteran affairs (DVA) and

workers compensation fund (WCF). Note that the titles and specific mandates of ministries/departments differ by country. Ministries of information and communication, technology, or transport were also mentioned during AT-Info-Map discussions as potential funders of AT, particularly related to infrastructure such as accessible transportation and accessible telecommunications though data was insufficient to describe further details about these sources.

Table 6.4 presents the government funding sources and eligible audiences covered by each source, grouped by those that cover broader or narrower populations.

Table 6.4 Government funding sources for AT

	Sources of government funding	**Eligible audiences**
Broad population coverage	Ministry of Health (MOH)	Beneficiaries of public health system
	Ministry of Education (MOE)	Students with disabilities at public primary, secondary and higher education institutions (universities, colleges, vocational schools).
	Ministry of Social Services, Welfare, Disability (MOSS)	Persons eligible for social protection programs (e.g., people with disabilities, children, orphans, persons living in poverty)
Narrow population coverage	Road Accident Fund (RAF)	Persons injuries in a car accident
	Works Compensation Fund (WCF)	Persons who were injured on the job, for those employed in the formal sector
	Department of Veterans Affairs (DVA)	Persons who served in military. Persons injured during war or war-related (i.e., landmines)

For all government funding sources, participants reported that AT and other services that target people with disabilities were not a prioritized by government officials during the budgeting process. Two reasons were lack of awareness about the extent of the need for AT and perception on behalf of some officials that social grants were best approach to addressing needs of people with disabilities. As one participant stated:

> *The starting point is for the government to acknowledge that persons with disabilities are a key population. 15% of our population is more than 1 million people. Once they acknowledge that they have to put some resources towards it. Our government approach to disability is more charity based, like you just give them destitute allowances, monthly allowance of like $20. (Leadership, non-profit)*

Unique aspects of government sources identified in Table 6.4 will be described below, starting with ministry of health (MOH). These descriptions will be followed by barriers and facilitators to increasing government funding for AT.

Ministry of Health

Given that many interviews participants worked with mobility devices, MOH (i.e., department of rehabilitation) was discussed most frequently as the primary public funder of AT. This focus on mobility devices by MOH also reflects international development community priorities as greater attention has been given to mobility devices thus far (WHO 2008, WHO 2011). AT is often framed as a 'health product' by the WHO (WHO 2017f), but there is a growing acknowledgment that policy, funding and provision crosses multiple sectors and ministries (MacLachlan, Banes et al. 2018).

South Africa was continually identified as the country with the most public funding for AT in the region and much of this funding was budgeted for under the MOH. MOH funding for AT (i.e., mobility devices) steadily increased over the past two decades which allowed local manufacturers scale up production overtime. Yet many participants agreed that the allocations for AT within the MOH were vastly inadequate, particularly in less resourced provinces. As described by one rehabilitation professional serving in KwaZulu-Natal:

> *Every year it is a fight just to try and get anything. So, this year I asked for 700,000 R and I got 89,000 R. I can't even buy cushions with that, and that is not the rest of the assistive devices, that is just wheelchairs. (Direct service, government)*

The primary explanation provided as to why MOH financing for AT was inadequate was the low prioritization of AT in public health agendas due to lack of awareness (i.e., extent of need, value of AT). Other explanations included the MOH budgeting structure and process and broader economic conditions, as described below.

AT budgeting within MOH in South Africa

Participants who worked within the MOH in South Africa, currently or previously, described problematic aspects of budgeting within the MOH. These issues are likely present in surrounding countries that also have allocated funding for AT within the MOH.

AT budgeting can take place multiple layers down within the organizational structure of MOH and with each layer the pot of potential funding is reduced. Funding for AT is often allocated from within the department of rehabilitation budget. Participants described departments of rehabilitation as having limited capacity and minimal political influence within MOH.

The negotiation process that determines AT budgets can happen at different levels of the health care system and this may differ by province. Levels include national, provincial, district and facility. One provider reported that AT allocations were made at the district level and then the facility level while another stated that AT was only budgeted for at the facility level. Both public providers who

served in different provinces in South Africa described how facility level rehabilitation/AT budget decisions were heavily dependent on the decision of one of two government officials who may have limited understanding of rehabilitation/AT and lack data on unmet need. Rehabilitation professionals are tasked to advocate to influence these decisions. As described by one rehabilitation professional:

> *There is a lot of negotiation that goes on to get money into that budget [AT], and it often depends on people at local level fighting for the budget. So, if there's nobody there to fight for it, it's not going to be there. (Direct service, government)*

Another rehabilitation professional describes AT budgeting conducted at the facility level:

> *So, the budget comes from national to province in the lump sum, province then decides how it is going to allocate that budget and it's still at a really gross level, no AT and rehabilitation allocation. They allocate to district and district allocates to hospitals. Hospitals then decide how to split budget into line items. So, it's all on a 'I decide to be nice to you' basis…There is no use of data to inform budgets whatsoever and that is not just for AT. (Direct service, government)*

Both providers described how the limited range of AT line items in the national budget accounting system made it more difficult to track and advocate for AT. For example, there is no line item for wheelchairs so these costs are pushed into outpatient services. Hence, there is no way to disaggregate what was spent of wheelchairs and know if wheelchairs budgeted for were purchased.

Influences of the broader economic context on AT budgets within MOH

Fluctuations in MOH budgets and subsequent allocations down the health system funding hierarchy generally correspond with the strengths/weaknesses of national economies. Participants from both South Africa and Zimbabwe described how only a small percentage of the population contributes to the tax base because of high unemployment rates. Yet a stronger national economy does not always guarantee that more resources are allocated for AT. For example, a few participants stated at least one country does have adequate financial resources but is just not prioritizing AT.

In Zimbabwe, the MOH has few if any funds to cover devices and related services due to the national economic crisis. As one rehabilitation professional stated:

> *My understanding is that even those basic things - a wheelchair, crutches - they are not there in our public hospitals so people [end users] have to buy. (Direct service, government)*

While participants only discussed how the strength of the overall economy impacted MOH funding for AT, it can be assumed that this is the case across all ministries that fund AT.

Ministry of Education

MOE was identified as a primary public funder of AT, particularly communication, vision, hearing, reading and learning AT. Some mobility devices were also reported to be provided through MOE. However, participants reported that funding was very limited in both South Africa and Zimbabwe, even though both countries have policies that explicitly mandate for education to be inclusive (Department of Education 2001, Chireshe 2013). When discussing the status of AT in public schools in South Africa, one participant stated:

> *If you send your kids to public schools, there is very little provision of AT so they parents have to pay. In specialized schools we can assume that AT will be there, which is not always the case. Sometimes the AT is very obsolete or is missing. There are schools for the blind that don't have Perkins Braillers or have a few but most of them are broken. (Direct service, for-profit)*

Another participant from Zimbabwe stated:

> *They [MOE] always claim that they have a budget support, for example hearing aids in public schools but again their budget is very small. (Direct service, government)*

The specific types of AT covered by MOE along with the quantity provided and costs was not known. However, one participant described one type of targeted AT funding provided through the MOE in greater detail. Students with disabilities enrolled in a public higher education institution are eligible for AT funding. Funding in the form of bursaries under the National Student Financial Aid Scheme (NSFAS) are provided to these qualified students to purchase a range of AT from preferred suppliers of mobility, hearing, vision and learning devices. Cost limits by types of AT are set by NSFAS with a maximum limit of R27 951 (approx. $2000 USD) for any type of device. AT provided through the bursary funding model requires professional assessments and product recommendations, and often the maximum limit does not cover the entire cost of the device.

Ministry of Social Services/Welfare/Disability

Each country in Southern Africa has a somewhat different configuration and mandate of social service ministries (Namibia - Ministry of Health and Social Services, Zimbabwe - Ministry of Labour and Social Welfare; and Lesotho - Ministry of Social Development). Most social service ministries have programs that target vulnerable populations including those with disabilities, which may include funding for some types of AT.

Only a few participants mentioned MOSS as a funder of AT and again few details were known about what type of AT were covered or budget levels. In Zimbabwe, AT programming and funding model combines both the MOH and Ministry of Labour and Social Welfare (MOLSW). Specifically, MOLSW

pays for most AT devices, and MOH covers rehabilitation services and specialized rehabilitation centres (e.g., RUWA Rehabilitation Centre – Spinal Injuries). While this system is currently not operating due to lack of funding, in theory a person would first receive a prescription for an AT device through a public health provider, and then locate suppliers and submit three quotes for this device to the MOLSW for review and approval. One participant reported that the MOLSW would then approve the most affordable of the three quotes, which may not be the most appropriate. This seemingly cumbersome process that may be unique to Zimbabwe allows MOLSW officials/staff who are unlikely to have AT expertise select specific products.

Road Accident Fund and Workers Compensation Fund

Both the RAF and WCF fund AT for injured individuals who are eligible. For persons injured in a road accident who require AT the cost will be covered in part or whole by RAF. Likewise, WCF covers AT for those injured on the job. Both funds are primarily funded through fees/taxes which provide more consistent streams of revenue for AT than the MOH or MOE budgeting process. RAF generates funding through a levy on fuel (cent per litre), and WCF taxes employers based on injury risk level of industry. A few private suppliers described these sources as better funders of AT than MOH or medical aid, covering a broader range of AT and higher allowable costs.

As described by one private AT supplier in South Africa:

> *There are two other [other than MOH] very big funders of AT, Road Accident Fund and Workmans Comp. under Department of Labor…It can be administratively intensive to access those funds but they got far more generous funding than, more often than not, even private medical aid. (Leadership, for-profit)*

The amount of funds provided to an injured individual for AT and related rehabilitation services is decided case by case, is based on professional assessments and can include a legal process. A few participants reported that high-tech and high-cost AT were more likely to covered under RAF such as a high-end motorized wheelchair and environmental modifications (e.g., accessible toilet). However, even when RAF agreed to cover a costly AT device, the percentage covered is liability-based so if the injured person is at all at fault, the percentage covered will be less than 100%. As one supplier explained:

> *What often what happens with that system (RAF), someone has 80% coverage but they cannot afford the 20%. Even though RAF may pay R300,000 for a product, they can't come up with the R60,000. That is why this liability-based system is a little problematic. (Leadership, for-profit)*

A few participants reported that coverage amounts from RAF and WCF can be inconsistent. Amounts can depend on how strong recipients or legal representatives advocate and there can be variations

in amounts funded between provinces. Decisions about the cost limit for a specific product are sometimes not based on professional recommendations. As expressed by a participant:

> *At the moment the RAF is very much like a potluck. Some people get incredibly good products and other people who maybe don't fight as hard may not get as good a product. (Leadership, for-profit)*

Limited information was provided by participants about workers compensation funds. One participant described the Workers Compensation Rehabilitation Centre in Zimbabwe that is funded under the National Social Security Administration that is within MOLSW. This centre provided a range of AT and rehabilitation services, and transportation to and from health services. Similarly, the WCF fund in South Africa paid for a range of medically prescribed services and products that could be accessed through private or public providers. Both WCF funds aim to re-integrated injured people back into work and society and do not cover domestic or informal workers.

It is not known if RAF and WCF funds exist in all Southern Africa countries. During interviews the RAF was only identified in South Africa, Botswana and Namibia and WCF in South Africa and Zimbabwe. A brief online Google search showed that RAF exists in Swaziland and Lesotho (Mkhize 2018, 2019) and WCF appears to be operating in many Southern African countries (i.e., Zambia, Namibia, Botswana, Lesotho, Swaziland, Tanzania). Most Southern Africa countries are also members of the International Social Security Association (ISSA), that sets international guidelines for WCF funds (International Social Security Association 2019). For example, ISSA's *Return to Work and Reintegration Guidelines* includes the provision of AT (International Social Security Association 2016). The ISSA is one entity that is well-positioned to help harmonize WCF AT funding policies across Southern Africa, which will be discussed further in Section 6.5 Policies.

War Victims/Veterans' Funds

War victims/veterans' funds were mentioned by a few participants when discussing AT funding for prosthetics in Zimbabwe. Two participants reported that this fund covered transportation costs to and from AT providers which greatly improved access for this population. One participant reported that a sizable population was covered by this fund because of the high prevalence of causalities from the Zimbabwe War of Liberation (1964-1979) and more recent landmine victims. It is not known if these types of funds exist in other Southern African countries that have experienced recent conflicts, specifically Angola (1975-2002) and Mozambique (1977-1992).

Constraints to increasing government AT financing

The low prioritization of AT among government ministries is the primary obstacle for increasing AT financing for products and services. AT awareness gaps and associated factors have been identified as the cause of low prioritization of AT (see Figure 6.3). Additional challenges include:

- Fragmented government funding sources: Six public AT funding sources were described in this section that operate in isolation and serve different or somewhat overlapping audiences. There are likely many more government sources that have yet to be explored. The fragmentation in government funding sources contributes to supply chain inefficiencies (i.e., lack of bulk buying) as described in Section 5.3 Product supply.
- High level of individual influence in AT funding decisions: Across all government sources AT budgeting decisions can be made by one or a few influential individuals (e.g., MOH officials) whom often lack AT awareness. The amount and types of AT budgeted for is inconsistent and often depends on advocacy ('fighting') by direct service providers, end users and legal representatives.
- Role of non-profits/charities: The belief that AT provision is not the responsibility of the government but of non-profits (donors, churches, etc.) undermines efforts to increase government funding for AT.
- Lack of knowledge about current government AT funding: The amounts budgeted for and types of AT covered by each government source was not known by interview participants. Participants had general impressions about AT funding levels and knew about select types of AT covered under different ministries based on their area of expertise. As one participant expressed:

  > *It is not clear which departments have budgets for disability. So, health is the main supplier of AT but also the department of education, there are cases where a child needs a device at school but if they also need it at home MOE doesn't cover that. I know sometimes Ministry of Social Development has funded some device. (Direct service, for-profit)*

  As described previously the lack of line items for many specific AT products within the MOH budgeting system makes it difficult to track AT spending by type.

Strategies to increase government AT financing from the perspective of participants

A model for increasing government AT funding was found in South Africa. The case presented in Box 6.1 describes the multiple factors that resulted in funding increases for mobility devices within the MOH.

Box 6.1 The South African case of increasing national government funding for AT

A few participants described how South Africa increased MOH budgets for mobility devices over the past 20 years. Trainings to relevant providers at state hospitals and procurement officials served to raise general AT awareness. Grassroots advocacy efforts by parents and other disability activists further helped prioritize AT among key MOH decision makers. As described:

> *The idea is to find key people in important positions across the health system who were in a position to influence further up the stream and then we helped those people to achieve their aim. So, you create a ground swell from the parents and therapists who want to do their job better, and then you empower the bureaucracy to put the right policy in place. (Leadership, for-profit)*

The background of supportive legislation (i.e., free health care to people with disabilities) helped strengthen advocacy efforts. Once service provided were educated about the appropriate provision of AT (i.e., wheelchairs) they became the drivers of advocacy that then was formalized into an advisory committee within one province. The policy development and subsequent funding increases implemented within one province eventually became national policy.

The advisory committee was comprised of service providers and for-profit suppliers and became institutionalized for the purpose of reviewing and revising mobility device policy. The primary policy tools developed were detailed tender specifications that included technical and clinical standards to ensure appropriateness, quality and local reparability of products. One participant emphasized the importance of the advisory committee:

> *What made the big difference was that we put together an advisory committee that really worked. We developed training and policy guidelines. (Direct service, for-profit)*

This model of establishing an advisory committee of key stakeholders to develop and implement tender specifications was used to increase provision of hearing aids.

The consistent increases in public budgeting for mobility devices overtime allowed local manufacturers to scale up production, as described by a private wheelchair supplier:

> *Increasing of budgets has been fairly consistent so from a manufacturing point it's been good. It is very difficult to create a factory for one years' good orders and next year there is nothing. South Africa has been stable and there has been a steady increase, so we have managed to grow the factories. (Leadership, for-profit)*

Participants who described this South Africa success story stated that awareness raising, particularly among service providers initially, was a critical ingredient to AT budget increases.

Another effective strategy for increasing AT budgets at the facility level was to target key public officials who made AT procurement decisions in awareness raising efforts.

> *I gave a presentation of what was rehab and why we need to spend money on it and one of the women in the room said afterwards, 'I am actually the treasury official who sets your budgets and I used to look at this line item and go what is occupational therapy, what is rehabilitation, I am sure it is not important but now I know it is important and I will give you money'. (Direct service, government)*

Beyond continuing to raise awareness, participants recommended two additional strategies to increase public financing for AT including developing a separate department/division that addresses AT and integrating rehabilitation and AT in primary health services.

One participant suggested that AT be moved out of department of rehabilitation and operate as a separate unit that is placed higher within the MOH organizational hierarchy. This unit would be responsible to AT policy, standards, education and monitoring; and would employ AT experts who had clinical and technical knowledge on the broad range of AT, not only mobility devices. These experts could then educate and advice relevant government official and service providers.

The second strategy comes from South Africa. One participant reported that rehabilitation services/AT were not integrated into primary health services though this goal was within the Framework and Strategy for Disability and Rehabilitation Services in South Africa 2015-2020 (National Department of Health 2015). Increased integration would, in theory, increase AT budgets as rehabilitation/AT would no longer be a separate add-on but part of other primary health services such as immunizations. Both these recommended strategies only address MOH though participants also expressed the importance of increases budgets within all primary government ministries (MOH, MOE, MOSS).

Along with increasing the overall AT budget a few participants agreed that the amount of funding, specific products selected and procured should be based on needs at the facility or school level. As one participant states:

> *I think what would work best is if individual schools would get their own budget for AT, because every school has got different needs. In South Africa there are many school categories - mild disabilities, cerebral palsy, schools for the deaf – so their budgets will not be the same. The district should give budgets to schools according to their needs. (Direct service, for-profit)*

Non-profit AT financing

Non-profits are international and local organizations (operating within one country) and include DPOs, advocacy and some professional organizations and churches. The behaviour of non-profits is

influenced by the international development community which includes a range of donors and intergovernmental agencies. Donors can be national aid agencies, private foundations, businesses or philanthropic individuals. Intergovernmental agencies shape global agendas (e.g., WHO) and/or implement programs (e.g., UNICEF).

Non-profits have played a major role in funding and providing AT in Southern Africa. In countries with weaker public sector engagement in the AT sector, non-profits are likely to have provided the majority of AT. Participants mentioned several international NGOs that are involved in AT provision including International Committee of the Red Cross, Mercy Corp, World Vision, Save the Children, LDS Charities, Equally Able Foundation, Light for the World, Motivation, Leonard Cheshire, Lions, Rotary and CBM.

Non-profit AT funding is inadequate and there has been more funding for mobility devices than other types of AT. As with government sources, inadequate funding was explained by the low prioritization of AT in the non-profit sector. Funding arrangements vary in focus and duration and may include monetary contributions, product donations, AT parts and material donations and/or support in strengthening the broader AT system (e.g., training personnel, designing policies). On the smallest scale one church may provide a few donated wheelchairs one time to people with disabilities within their community. At a national scale an international NGO may develop a long-term partnership with government to help finance select types of AT within the health or education systems.

Non-profit product donations or funding received by government is often used to supplement inadequate public budgets. One example is the Kachere Rehabilitation Centre in Malawi that serves people with spinal cord injuries. This centre seeks outside donations in any form (e.g., equipment, products, food, funding) to fill the funded gap because the government only covers 65% of annual operating costs (2018). Blending funding from non-profits and governments is common with AT and other health products (e.g., medicines).

Next, the key characteristics of non-profit AT financing will be described, most of which are problematic. A summary of the relationships between non-profit and government AT financing is also provided, followed by strategies for strengthening non-profit funding for AT.

Key characteristics of non-profit AT funding

Inconsistent non-profit funding for AT

Non-profit funding is inconsistent in the amount of funding, duration and focus areas. External agendas often shape funding priorities of international NGOs and lack of data extent of need poses a challenge to planning. AT funding varied overtime and fluctuated with external grant funding cycles

and objectives. Non-profits may shift priorities so may fund a specific type of AT (e.g., hearing aids) one year but not the next, or cease AT funding all together. For example, an international NGO that provided wheelchairs in Zimbabwe stopped operating in 2018 due to budget limitations. One participant reported that this left a 'huge gap' in national wheelchair provision. For a for-profit supplier who sells AT to non-profits, the fluctuations in AT funding make it difficult to forecast demand. Combined with the absence of data on unmet AT needs, fluctuations in non-profit buying of AT overtime hinders the growth of the AT market.

High level of fragmentation in AT funding from non-profits

Fragmentation among non-profit funding is partially due to the sheer number and diversity of international and local non-profits, and tendencies for funding to target specific types of AT or subpopulations. Lack of coordination among non-profit actors exacerbates fragmentation and redundancies in programming.

The scope of international and local NGOs programming is often piecemeal in that one type of AT, a narrow population, or one part of the AT system is addressed (e.g., training wheelchair technicians on conducted assessments). Numerous examples of segmented populations and AT types were described. Some non-profits serve larger groups such as children with disabilities and others target very small populations. A prosthetist illuminates this point in a discussion about how complicated it is to keep track of which funders cover which clients:

> *We have organizations who are only funding clients that have been amputated due to cancer…so if there is any other cause, they don't take it. (Direct service, non-profit)*

Small local non-profits with a narrow target audience (e.g., Multiple Sclerosis (MS) Society) often seek out their own funding and product donations, as one participant describes:

> *Most the NGOs/DPOs have a specific target. So, you'll have the MS Society, Muscular Dystrophy Society, QuadPara Association, and they look after their member's needs. So, they will have fundraisers, events, arrange for donations, etc. (Direct service, for-profit)*

When multiple international NGOs are addressing AT needs in the same region this can create redundancy in programming which further fragments an already very divided sector.

Asymmetries in non-profit AT programming

One participant described how an international NGO trained local providers in appropriate wheelchair provision (e.g., product selection and customization) yet the limited products available did not allow these trained providers to apply their new knowledge and skills. The opposing case was

also reported when appropriate AT products were funded but no trained personnel were trained or funded to provide these devices.

Inadequate system level non-profit AT programming

Some international NGOs have made efforts to develop the national AT systems in partnership with government though only focused on a few types of AT. One example involved establishing national taskforces that were responsible for coordinating wheelchair provision among all stakeholders and advocating for national policies. These taskforces had varying degree of effectiveness in each country depending of the level of support and engagement from government. The more common experience reported by participants was that international NGOs did not address the needs of the AT system more holistically but instead focused on their specific projects. As described by a participant:

> *The people I worked with were fantastic people [referring to international NGO], and really passionate about what they do but they really don't understand the bigger picture of it. They do the WHO training, basic seating training, but it is completely geared to their project. It's all about their wheelchairs and their project, they don't teach it as principles of setting up a sustainable assistive device provision service so they see it as, you are going to administer our project so this is how you do it. (Direct service, for-profit)*

Non-profit AT programming lacks alignment with local partners

A few participants reported that the design and implementation of some international NGO AT programs lacked alignment relevant ministry agendas or capacity, and/or expressed needs of local advocacy and disability service organizations.

Relationship between government and non-profit AT financing

Greater non-profit sector funding and engagement in AT procurement and provision can endorse the perception that government is not responsible for funding and providing AT. One participant identified several countries where non-profit dependency is the norm:

> *They [Zimbabwe] rely on donor funding because that is what they expect. Donors have funded in the past so keep doing it, why waste resources on it, so it's a learned dependency. Same in Mozambique, Lesotho, Swaziland, Uganda. (Leadership, for-profit)*

A few participants described how less MOH and MOE funding for AT was associated with more dependence on international donors/non-profits. South Africa, Namibia and Zambia were identified as countries with higher levels of public funding for AT and thus a minimized role of international non-profit/donors.

A case that exemplifies dependency on international donors can be found in Zimbabwe. The Swedish International Development Agency (SIDA) was the primary funder of the national rehabilitation

system that provided a range of AT and disability related services in the 1980s and 1990s. A few participants reported that this national system collapsed after SIDA pulled out funding. The fact that this externally funded rehabilitation system was managed by the MOH gave one participant confidence that the MOH has the capacity to manage the system again if funding could be made available. Given the ensuing economic crisis, participants did not expect this national system to be revived anytime soon.

The lack of responsibility assumed by government has also resulted in a few NGOs pulling out of a country as there was no indication that their funding and efforts would be integrated into the public systems.

Strategies to increase non-profit AT financing from the perspective of participants

Increasing AT funding within the international non-profit sector requires elevating the priority of AT within global health and development agendas which is starting to happen. There is a growing recognition that addressing the needs of people with disabilities is critical to achieving the Sustainable Development Goals, among other prominent global policy instruments (i.e., CRPD, WHA71.8).

The way non-profit funding is allocated has much room for improvement to reduce fragmentation and inconsistencies, and to ensure appropriate AT provision. AT funding should be consistent and holistic to strengthen national AT systems. Approaches should also be designed to reduce dependency level on governments on the non-profit sector.

One proposed strategy to reduce fragmentation in funding and increase supply is to aggregate AT buying power among international non-profits. The market shaping initiatives introduced in Section 5.3 Product supply, proports that aggregating buying power will bring down costs of AT and stimulate demand. If this aggregated buying power was targeted towards direct and full-service suppliers this could increase post-sale services, ensure appropriateness of devices and reduce costs.

Channelling funding and AT products through international NGO may increase supply while serving to bypass national infrastructural challenges. In Zimbabwe an international NGO was able to avoid using the unreliable and costly national banking system and order AT products directly from manufacturers from a foreign-based bank account.

Medical aid AT financing

Medical aid (for-profit health insurance) only cover a small percentage of the populations within Southern African countries. Participants estimated that between 5-15% are covered, with highest percentages of national populations covered in South Africa and Namibia. Medical aid companies

differ by country and regulations that shape market entry and behaviours (see Section 6.5 Policies). Two characteristics of medical aid AT funding described below are inadequate AT coverage levels and bureaucratic processes.

Inadequate AT coverage by medical aid schemes

In South Africa there are more than 60 different schemes (Council for Medical Schemes 2019b). Services and products covered by different medical aid plans vary significantly and most have limited, if any, coverage of AT or rehabilitation services. Participants described a wide range of AT types that were not typically covered under medical aid schemes including hearing aids, eyeglasses, blind mobility training, accessible ICTs and communication devices.

One private supplier discussed why medical aid does not cover communication AT, stating:

> *Lack of knowledge. People do not understand a disability that is not physical. So, it's not counted when we go to medical aid. (Direct service, for-profit)*

Medical aid plans may have other restrictions that limit access and sustained use of AT such as only covering AT that is provided during hospitalization and not covering AT related services including repair or replacement.

A few participants agreed that medical aid rarely covered high-end AT such as a motorized wheelchair with seating supports for someone who is quadriplegic. Covered AT is often the 'cheaper' option and recipients will still pay a percentage of the approved product cost. A prosthetist from Zimbabwe described how the two most robust medical aid schemes only cover $300-$1,500 per prostheses and patients cover 20% of the cost. This inadequate coverage can result in patients not receiving the prescribed device.

> *As a professional, if I recommend a certain type of prosthetic, they [medical aid] do not consider that. They say our scheme only pays 80% of the maximum 1.5k, full stop. (Direct service, for-profit)*

Another prosthetist reported that surgeries are more commonly covered by medical aid than AT, even when the latter is less costly and may prevent the need for surgery.

> *We are faced with a challenge...of getting medical aids to fund a brace for a child, but they won't allocate the same amount of funding for conservative management as they would for surgery. There is just a huge imbalance. And that is really the challenge we are faced with…They will pay R200,000 to 300,000 for surgery but they won't pay a 1/10th of that for a brace. (Direct service, for-profit)*

Bureaucratic processes

Another challenge identified with medical aid was the time-intensive process required to get products registered under each scheme. This process barrier limits the range of products available as

suppliers find it too costly and time consuming to get a wide range of products registered. Likewise, getting new product innovations registered is a lengthy process.

Strategies to increase medical aid AT financing from the perspective of participants

One proposed solution was to advocate to medical aid regulatory bodies for increased AT coverage. Regulatory bodies are responsible for creating and enforcing policies that shape practices of medical aid companies. The Association of Health Funders in Zimbabwe (http://www.ahfoz.org/) and the Council for Medical Schemes in South Africa (https://www.medicalschemes.com/) are mandated to regulate medical aid schemes within the respective countries though the level of implementation is uncertain.

> *They [Council for Medical Schemes in South Africa] are trying to regulate and get things like 'prescribed medical benefits" so medical aid can't offer less than what a state hospital would offer a state patient, but there is still lack of understanding and lack of implementation. (Direct service, for-profit)*

Another approach that is starting to gain traction is to demonstrate that it is more cost effective to provide AT versus the alternative (e.g., orthopaedic surgery, unemployment). One for-profit supplier reported that medical aid companies and employers have started to fund non-medical AT such accessible ICTs (hardware and software) for this reason:

> *For a medical scheme to give software to keep somebody employed is much cheaper than paying somebody to stay at home because they are boarded medically [not able to work due to disability]. (Direct service, for-profit)*

Without coverage for AT in medical aid plans, some individuals in South Africa are electing to purchase separate disability insurance that covers disability related needs. As reported by one participant:

> *Many people who can afford it will have specific disability funding, a separate policy that will pay out if you become disabled. It will cover you for really expensive wheelchairs, etc. (Direct service, government)*

Strategies to strengthen AT funding from the perspective of participants

Increased funding for AT products and services is required across all government, non-profit and medical aid funding sources. Participants who were aware of how MOH financing for mobility devices increased in South Africa, described critical ingredients to the process that took place over a 20-year period. Increasing awareness, advocacy efforts and the formation of an advisory committee that developed and refined tendering specifications were some of these ingredients.

Participants also described ways to increase AT funding and improve the way funding was allocated across all sectors. Strategies to strength AT financing that were proposed by participants are described in Table 6.5 below.

Table 6.5 Recommended strategies for strengthening AT financing

Categories of funding sources	**Recommended strategies to strengthen AT financing**
Government	• Educate key government officials involved in AT procurement about AT (range of products, services, uses, value). • Restructuring so AT decision making is higher up within MOH, not a subset of the department of rehabilitation • Integrating the provision of AT into primary health services
Non-profit	• Implement holistic AT programming, not fragmented by AT type, subpopulations, or asymmetric designs (e.g. funding AT but not services). • Design to decrease government depending on NGOs • Aggregate buying power among international NGOs
Medical aid	• Advocate to national bodies that regulate medical aid companies for 'minimum prescribed benefits' to include AT • Demonstrate cost benefit of providing AT versus alternative

Synopsis of AT financing building block

The specific characteristics of AT funding across the three primary funding sources (government, non-profit, medical aid) and how these characteristics differs by country is not known. Without knowledge of the current AT funding capacity, it is challenging to determine the gaps, develop strategies to increase funding and monitor progress. While it is not possible to answer basic funding questions (i.e., What types of AT are covered and how much funding is provided by different government ministries and other sources?), it was possible to make broad generalizations from these data about the similarities and differences across funding sources.

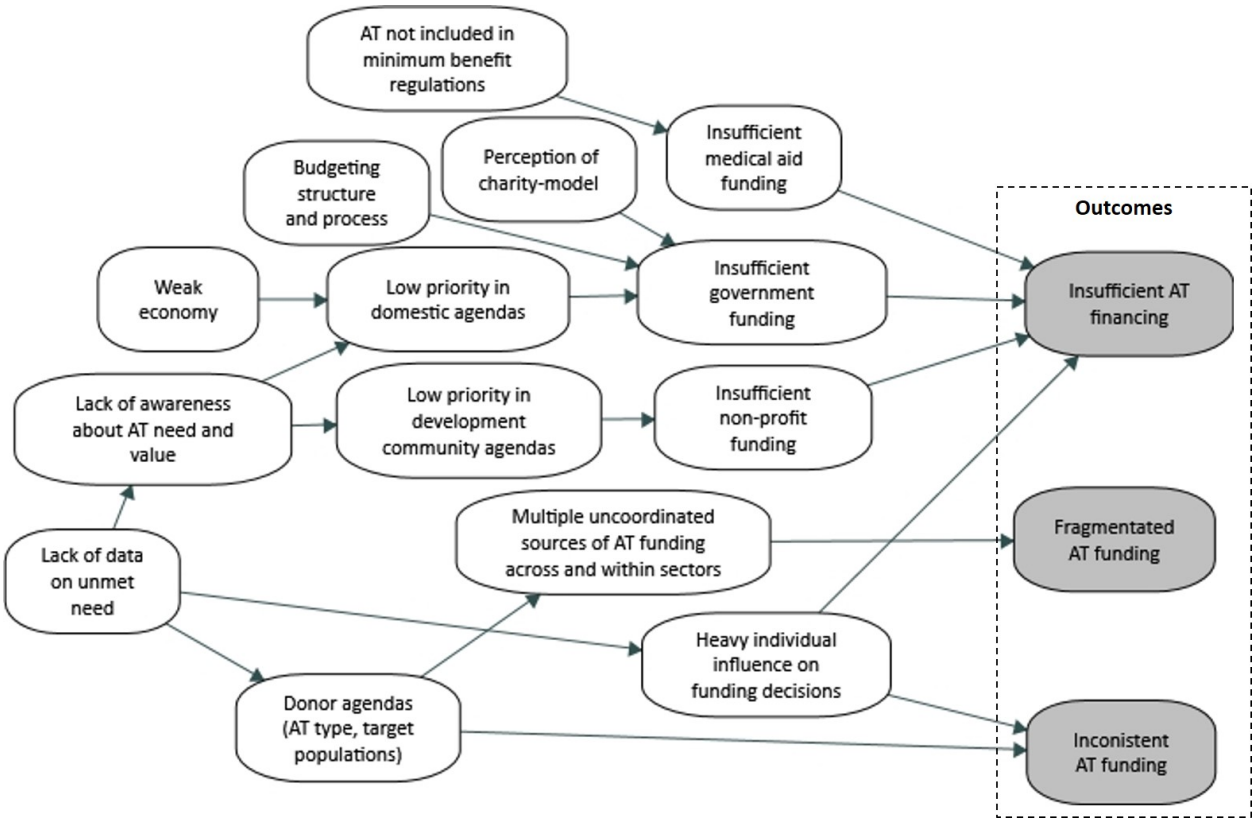
Across all three funding groups, AT financing for products and services is inadequate though there is relatively more funding available for mobility devices than non-mobility types of AT. Low funding levels are attributed to the low prioritization of AT and several other interrelated factors such as inadequate regulations and lack of evidence on AT need/demand. Among government sources inadequate funding is also attributed to the budgeting structures and processes, strength of the overall economy and level of dependency on non-profits.

Fragmentation in AT funding results from the multitude of sources within and across government and non-profit sources that operate in isolation. The most highly fragmented source are international and local non-profits that often segment programming by AT types and population and lack coordination.

Amounts funded and types of AT covered are inconsistent across and within sources and over time. Within the non-profit sector AT funding fluctuates with donor agendas. The heavy influence of one or two individuals on funding decisions combined with lack of evidence also contributes to funding inconsistencies across sectors. When these few decision makers lack AT knowledge, the budgeting for AT and selection of specific AT products are often not based on professional recommendations.

Figure 6.5 displays that contributing factors to the key characteristics identified in this section, specifically insufficient, fragmented and inconsistent AT funding.

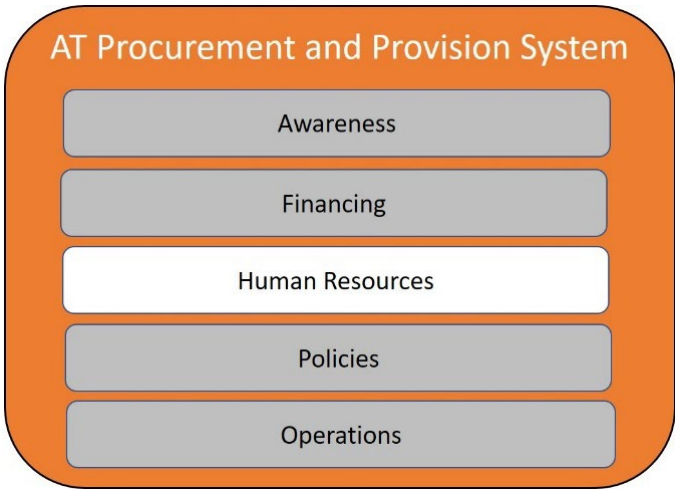
Figure 6.5 Financing building block: Outcomes and contributing factors



6.4 HUMAN RESOURCES

Human resources within AT procurement and provision system (Figure 6.6) are inadequate in terms of quantity of direct service personnel, geographic reach and the quality of services provided.

Figure 6.6 AT procurement and provision system: Human resources building block



Direct service providers of AT include rehabilitation professionals from various disciplines namely physiotherapy (PT), occupational therapy (OT), speech therapy (SLP), audiology, prosthetics, orthotics and social work; educators, particularly those who work in special education; and other AT professionals who provide expertise in specific types of AT (i.e., accessible website design, low-vision technology). The characteristics and causes of the inadequate AT workforce are described below followed by strategies for increasing capacity. Inadequacies described include the shortage of direct service providers and poor quality of AT services. Consistent with other sections, participant discussions about human resources were primarily focused on MOH and mobility devices (i.e., wheelchairs and prosthetics).

While a wide range of personnel are needed along the supply chain to ensure the efficient and appropriate provision of AT from manufacturers to end users (e.g., importers, exporters, product distributors, procurement officers), this discussion on the human resources building block focuses solely on direct service providers.

Shortage of AT direct service providers

All participants reported that there is a shortage of direct AT service providers across Southern Africa with the vast majority of providers serving in South Africa. While there is agreement that the AT workforce is inadequate, the extent of the unmet need is not known. In Zimbabwe one prosthetist reported that there were only five trained prosthetists in the whole country but did not know how

many more were needed. Another government provider described the challenge of capturing the capacity of the current rehabilitation workforce in South Africa:

> *There is still confusion as to how many therapists we actually have in the public sector, where they are sitting, what profession they are, what level they are. That's how little information we have. (Government, direct service)*

Two reasons identified for the shortage of direct service providers were 1) lack of funding for AT services and 2) rigorous qualifications for a few select AT provider disciplines.

Lack of funding for AT services

Lack of funding was consistently identified as the primary cause for the shortage of direct service providers. Funding was insufficient for jobs (posts) and for coverage of services. The underlying factors that explain the lack of funding for AT direct service providers are the same as those identified in Figure 6.5 Financing (e.g., lack of general awareness that deprioritizes AT within government and non-profit funding agendas). The lack of awareness about services needed to ensure the appropriate provision of AT can result in funding for AT products that are not be matched with required AT-related services. As described in Section 6.3 Financing, asymmetries in non-profit AT programming are when products funded without services or vice versa.

The lack of trained rehabilitation professionals available in the labour market was not identified as a problem by most participants. A sufficient amount of postgraduate training opportunities are available that cover a range of rehabilitation disciplines, particularly in South Africa. However, trained direct service providers often cannot find job opportunities (posts) due to lack of funded positions. In referring to OT graduates in Zimbabwe a participant stated:

> *Everyone graduates and the first thing they ask is how can I get out of the country. So, who is left to recommend and prescribe assistive devices? The people who were able to share that information have left the country so that is one of the major challenges. (Direct service, government)*

Likewise, in South Africa there are few posts for graduated physios in the public sector once they complete their mandatory year of community service.

> *Once they finish community service, they literally either have to leave the country, change their profession or try to get into the oversaturated private market…So, the private sector services about 16% of South Africa population. Depending on what stats you believe, between 65-80% of physios work in the private sector. (Direct service, government)*

This participant also described how the South African government is putting pressure on postgraduate rehabilitation programs to increase enrolment numbers even though the bottleneck is lack of funding for posts and not the lack of trained rehabilitation professionals.

While there may be an adequate supply of trained rehabilitation professionals in the labour market, other types of AT professionals are lacking in the region. For example, one participant reported that there were few professionals that work with accessible design (e.g., websites, media) and/or ICTs for people with low-vision.

Rigorous professional qualifications for select direct service providers of AT

Rigorous professional qualifications for certain types of AT direct service providers may pose a barrier to increasing workforce capacity. One participant described how blind mobility trainers require a high level of certification and thus there are few qualified trainers in South Africa. This participant recommended that standards be lowered to increase numbers of blind mobility trainers.

Another participant mentioned that becoming a rehabilitation technician was more accessible than other rehabilitation professions because fewer qualifications are required. Training schools for rehabilitation technicians were only identified in a few countries (i.e., Zimbabwe, Malawi). Rehabilitation technicians are generalists, require less training than postgraduate physiotherapy programs, and are more likely to conduct outreach services within communities.

Poor quality of AT services

The quality of AT services is compromised by service coverage constraints and gaps in competencies among providers. Poor quality services increase the inappropriate provision of AT, the rate of AT abandonment, and ultimately reduce outcomes achieved by clients such as returning to employment or community integration.

Service coverage constraints

Constraints placed on AT services in the quantity and duration of appointments can result in low quality services. Medical aid and government funding sources place restrictions on the amount of services covered. These restrictions are greatly due to inadequate AT financing but may also result from lack of awareness about the need to match appropriate products with services.

An illustration of service constraints was provided by a prosthetist in Zimbabwe who had experience working in both the for-profit and government sectors. The prosthetist described how the MOH only budgeted for a few visits per clients which was not adequate for fitting and follow-up services. Thus, many patients would abandon their newly acquired artificial limbs. Clients who received for-profit services by paying out of pocket could increase the number of visits to ensure the prosthetic leg

matched their needs. In this specific case, the model of care also lowered the quality of AT services. Amputees were assigned to rehabilitation professionals on a first come first serve basis per appointment visit which often resulted in clients seeing different providers for each visit. This lack on continuity in care was particularly problematic for the provision of prosthetics that requires high level of customization and multiple adjustments overtime.

Participants reported that direct service providers are facility-based, many working at centrally located and often urban rehabilitation facilities or hospitals and less commonly found in primary health or community-based facilities. Community-based rehabilitation programs (CBR) were mentioned by one participant as AT services that operate in close proximity to end users, particularly in hard to reach areas. These CBR programs may be the only services reachable by people with disabilities in rural locations.

Funding policies that restrict AT services to health facilities result in lack of services provided to clients that are not able to leave their home or transport themselves to the facility. Even when rehabilitation goals include functioning within the home environment, home-based services are not covered. One OT describes the facility-based nature of their profession:

> *For instance, if I have a client who I am treating with occupational therapy, their expectation in terms of treatment is just to be out of the hospital. If I want to treat them beyond the hospital, they don't expect that OT will come to their home and assess, and the cost of that provision for me as an OT is not covered, so me to travel to do an assessment at the client's home is not covered…How do I know their home environment when the structure does not support me to do home visits? (Direct service, government)*

Gaps in competencies of direct AT service providers

As described in Section 6.2 Awareness, AT direct service providers often lack awareness of the broad range of AT possible and potential benefits to people with disabilities. Participants also reported examples of gaps in clinical and technical skills, and other professional competencies. For example, two participants reported specific gaps in clinical training within prosthetic programs. Training received only included lower limbs, not arms, and lacked the high level technical skills required to customize a prosthetic socket. Another example was of a postgraduate PTs who were not trained in seating and positioning.

Gaps in professional competencies go beyond clinical and technical skills. Specifically:

- Lack of knowledge about AT system operations: Specifically, providers need to know how to select, order, track and provide products appropriately. For example, direct service providers

in the public sector need to know the government AT tendering policies, what products and suppliers are on tender, and the product ordering process for products on and off tender.

- Lack of advocacy skills: Advocacy is needed to increase the quantity and quality of AT products and services provided within their facility/organization and the broader national AT system. While advocacy is not required skill within direct service provider disciplines, participants in South Africa described both government and for-profit providers as playing a critical role in increasing quantity and quality of AT provision.
- Inadequate administrative skills: Given the scarcity of AT providers, particularly in rural areas, direct service providers are often tasked with an array of administrative duties that extend beyond their clinical role though do not receive training in these tasks. One government rehabilitation professional serving in a rural district hospital also helps manage the stores department that procures and stocks AT and other medical products, stating:

> *I spend inordinate amounts of time in my stores department, trying to get them to procure the right thing [products] and not lose my paperwork. I can only do that because I do not have a high clinical workload. The average OT at an average district hospital does not have 4 hours per week to go babysit their stores department. (Direct service, government).*

As mentioned previously, the lack of professional training programs was not identified was a cause of the shortage of direct service providers. However, the curricula within these professional training programs is inadequate to equip these providers to meet end user AT needs and strengthen the overall AT system.

Training program and curriculum for direct service provider

The majority of rehabilitation training programs that include AT content are based at South African universities. The World Federation of Occupational Therapists (WFOT), World Confederation of Physical Therapy (WCPT) and International Society of Prosthetics and Orthotics (ISPO) show the following number of 'recognized' postgraduate rehabilitation training programs available in Southern African countries (see Table 6.6) (International Society for Prosthetics and Orthotics 2019, World Confederation for Physical Therapy 2019, World Federation of Occupational Therapists 2019).

Table 6.6 Number of rehabilitation training programs by country

Country	OT	PT	P & O
South Africa	8	8	2
United Republic of Tanzania	1	2	2
Zambia	1	2	0
Malawi	1	1	0
Madagascar	1	1	0
Mauritius	1	1	0
Zimbabwe	1	1	1*

*One participant stated that a new P & O program is going to offered through the University of Zimbabwe in the near future.

One of the ISPO recognized training programs in Southern Africa is the Tanzania Training Center for Orthopaedic Technologists (TATCOT). A few participants spoke highly of the training they received in prosthetics, orthotics and wheelchairs provided by TATCOT. The TATCOT training for these participants was funded by external donors. TATCOT reports that as of December 2017, they trained 752 people from 32 African countries since they were established in 1981 (TATCOT 2019).

A few participants reported that the AT curriculum for rehabilitation trained programs lacked content on the range of AT and skills were not contextually relevant to the realities of most clients receiving services through the public health system, especially those in rural settings. A government provider that manages rehabilitation staff at a district hospital stated:

> *You need to train your therapists up…The syllabus [physios] is broad, not covering AT, and it's still based very much, in my opinion, on private sector first world. So, our therapists are coming out very good at acute care at a tertiary hospital and musculoskeletal practice, and they have no clue what to do with a spinal cord injury or the kids with cerebral palsy in the community that you are going to see once a month. They have no idea about seating or how to integrate assistive devices into their treatment implementation, so they will issue the device and then expect the person to know what to do and use it automatically but that doesn't happen. (Direct service, government)*

In South Africa where health care graduates are required to serve a year of community service, they often serve in rural and other under-resourced areas. One government direct service provider described how rehabilitation training programs were not preparing new graduates for their compulsory community service:

> *So undergrad training is not equipping our guys with what they need to do in the bush which is where we are expecting them to get placed. They have to do their community service and they operate usually unsupervised in a pretty challenging environment with pretty severe cases. (Direct services, government)*

Some participants sought out additional training opportunities that were not available through their postgraduate programs. One OT completed the RESNA AT Professional Certification to develop skills in a broader range of AT, particularly ADLs (RESNA 2019). A prosthetist was working on a master's in psychology to better serve amputees who were recovering from trauma. A special educator from Zimbabwe received an honours degree in Augmentative and Alternative Communication (AAC) through the University of Pretoria that also offers a masters and doctoral degree in AAC.

The only international training program mentioned by participants was the WHO Wheelchair Service Training Packages (WHO 2019c). These training packages were described as effective in raising awareness and developing skills in appropriate wheelchair provision. Participants who received this WHO training in Zimbabwe reported that they learned to identify and filter out inappropriate donations and make product adaptations so that wheelchairs were more suitable for end users and the environment. The training was provided as part of a USAID funded grant and it is not known if these training packages have been integrated into professional training programs within Zimbabwe or other Southern African countries, though this is a stated objective of WHO.

> *An important aim of the training package is to get it integrated into the regular paramedical/rehabilitation training programs such as physiotherapy, occupational therapy, prosthetics and orthotics, rehabilitation nursing. (WHO 2019c)*

Unqualified redundant intermediaries

As described in Section 5.3 on product supply, the provision of AT by redundant supply chain intermediaries often results in inappropriate products and services. Professional associations such as national orthotic and prosthetic associations, establish and enforce regulations to prevent unqualified people from providing AT. Yet these regulations are challenging to enforce given the large number of unqualified suppliers that are providing services and the broad range of professional disciplines involved in AT provision.

Strategies to strengthen the AT workforce from the perspective of participants

Participants identified existing and potential solutions to increase the quantity of AT direct service providers and improve the quality of services.

The existing strategies to increase the capacity of services were small-scale and often dependent on donor funding. Strategies include:

- Flying in rehabilitation specialists to rural settings: In a rural district in South Africa, prosthetists are flown in once a month to provide service to people on a waiting list.

- Peer support programs: A peer support program developed by a government direct service provider and funded by a private donor has increased the availability and quality of wheelchair services within this same district. Peer supporters are trained in wheelchair repair and provide training on wheelchair skills and repair services at clinics and within the community. The program has been well-received by wheelchair users in the community, as described:

> *The peer support add that element, where you get so much more bang for your buck, you start to build up a wheelchair community in that area so people start to share with each other and get to know each other…You also get the buy in because I am can tell somebody until I am blue in the face about their bladder and bowel…but they listen to the peer supporter because he has a spinal cord injury and is in a wheelchair while I am just a therapist. (Direct service, government)*

- Government non-profit partnerships: AT professionals from a local non-profit visit a district hospital four times per year to provide blind mobility training and issue walking sticks and low-vision devices.

Three potential strategies recommended for increasing the capacity of the AT workforce targeted government:

- Purchase from direct and full-service suppliers: For-profit manufacturers and suppliers who have AT expertise often provide training and other post-sale services alongside the product. As described earlier, these suppliers have the in-depth knowledge and skills to expand sales and services but are restricted by the market demand across all sectors. Increasing government funding to procure AT products and services from direct and full-service suppliers was one recommended strategy for increasing capacity of the AT workforce.
- Create an intersectoral human resources coordinating body: Another government led strategy mentioned was to establish an intersectoral body that is responsible for identifying and addressing AT human resource needs. This body would include the relevant departments, professional associations, for-profit suppliers and grassroots representatives. As expressed by one participant when discussing the MOE:

> *We need a platform between the department of higher education, professional boards, professional associations, and key service providers at grassroots level so that we can coordinate how many students we are intaking, graduating, what the syllabus is actually preparing them for, the needs at grassroots level, what the key competencies should be for employment. (Direct service, government)*

- Expanding and increasing contextual relevance of AT curriculum: Professional training programs provide limited exposure to the range of AT possible and potential beneficiaries. AT skills and knowledge also needed to reflect the everyday realities of end users, particularly those residing in rural or other underserved areas.
- Increase number of AT generalists: Invest in training and funding rehabilitation technicians or other AT generalists that can serve broad AT needs that do not require a highly trained specialist.

Synopsis of human resources building block

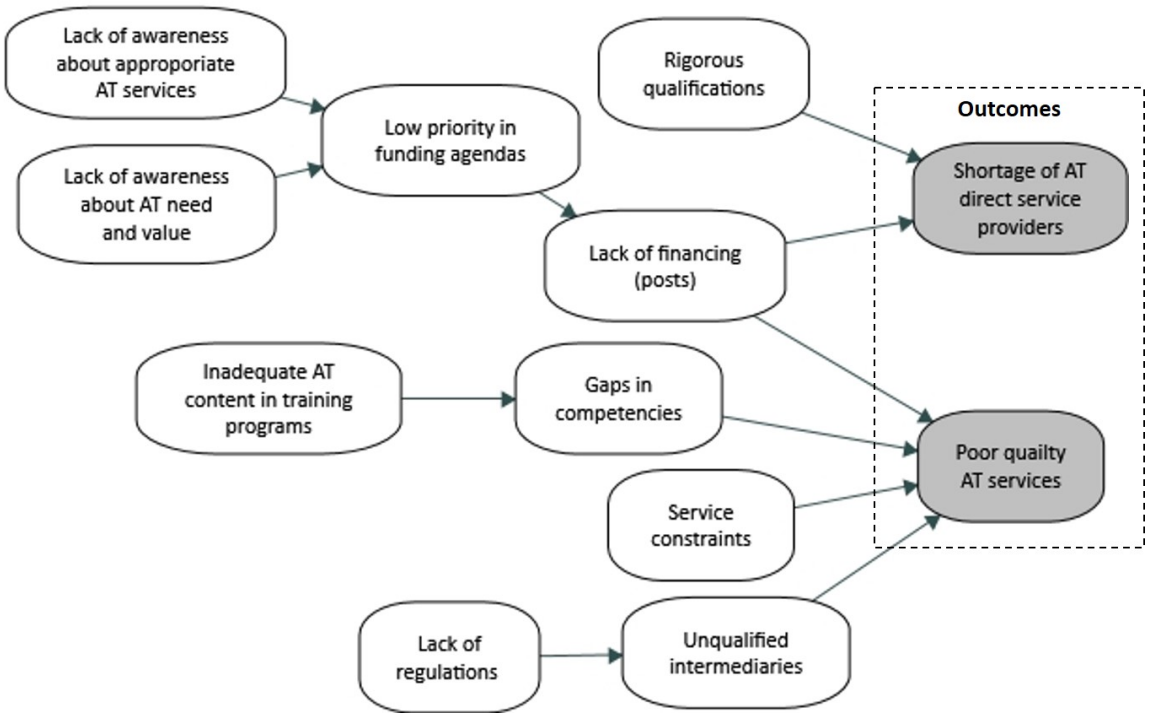
Findings presented primarily focus on rehabilitation professionals within the health system though there are a wide range of direct service providers within the AT sector such as special educators and accessible ICT specialists. Two key characteristics (outcomes) of AT human resources building block are 1) the shortage of direct service providers and 2) inadequate quality of services. Underlying causes of the two outcomes are presented in Figure 6.7 and summarized below.

The shortage of direct service providers is mainly attributed to inadequate funding. The lack of funding for government posts across the region results in many trained rehabilitation professionals finding jobs within the small for-profit sector or leaving the Southern African region for opportunities aboard. Most rehabilitation professionals are trained and serving in South Africa. Even when funding is available for AT products, matching services to ensure appropriate assessments, fitting, follow up and repair may not be funded.

Poor quality services are due to gaps in AT knowledge and skills among direct service providers, unqualified intermediaries, as well as constraints of services. Curricula of training programs for direct service providers lack knowledge about the broad range of AT possible and contextually relevant skills. Redundant intermediaries often lack AT expertise and provide inappropriate devices and services. Limited coverage for services such as too few visits provided per client or services restricted to facilities without providing transportation also compromises quality.

Inadequate funding for services on behalf of government, medical aid and non-profit sources is the primary barrier to increasing both the quantity of the AT workforce and quality of services provided. As described in Section 6.3, inadequate funding is characterized by insufficient, fragmented and inconsistent funding for AT products and services, and the low prioritization of AT is the key underlying factor.

Figure 6.7 Human resources building block: Outcomes and contributing factors



Given that AT providers are often advocates for improved AT services and increased budgets, increasing the overall capacity of the AT workforce can also serve to strengthen the broader AT sector. The absence of data to determine the extent and nature of the AT workforce shortage also hinders advocacy and policy making efforts.

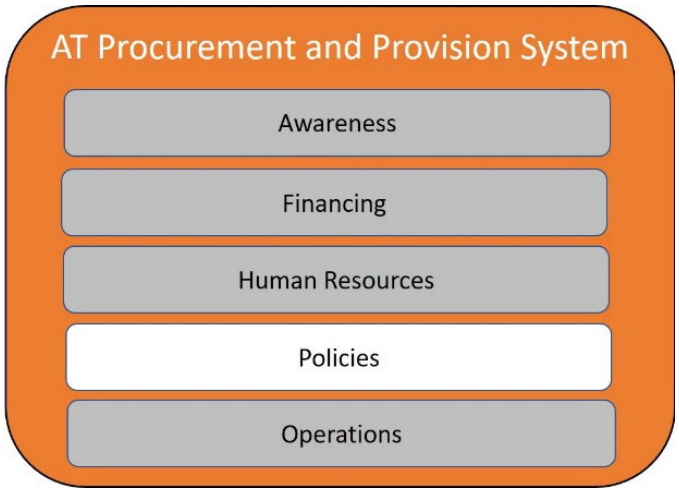
6.5 POLICIES

A complex array of policies at international, national and organizational levels influence the supply of and access to appropriate AT in Southern Africa. This section summarizes AT-related policies that were discussed by interview participants, AT-Info-Map stakeholders and located in policy documents. For the purpose of this study the term policy is applied broadly to encompass laws, regulations, standards (including technical product specifications), guidelines, action plans and agreements that shape AT supply and access.

All participants made at least a minimal reference to policies when discussing barriers to AT access, particularly access to appropriate products and services. However, few specific details were provided about existing AT policies, or regulatory bodies and processes required to develop, monitor, refine and enforce policies. The lack of specificity combined with the range of AT policies that operate at different levels and sectors, often overlapping, led to superficial discussion that points to broad challenges in the AT policy environment.

Policies that underly all other building blocks within the AT system such as awareness or operations (Figure 6.8) will not be covered in this section because the focus is on policy topics that came from data sources. An in-depth and systematic examination of AT policies was outside the scope of this study and is recommended for future studies. In the Chapter 7 Discussion, a summary of policy gaps derived from the broader health product literature will be provided.

Figure 6.8 AT procurement and provision system: Policies building block



Policies described below have been grouped into three broad categories: 1) Contextual, 2) AT-specific, and 3) trade and industry. Contextual policies include language about AT within larger aims (e.g., disability rights) and serve primarily as normative frameworks. AT-specific policies focus on AT product and service regulations, standards and guidelines. The third category, trade and industry,

include policies that influence the AT market such as importation tariffs. Examples of the policy-making and implementation processes also provided followed by a summary of major challenges and solutions for strengthening AT policies.

Contextual AT policies

AT is addressed within numerous contextual policies, signifying the importance of AT in achieving a wide range of broader disability rights and health policies at the global and national level. The contextual policies described in this section are often referenced in advocacy efforts, AT academic literature and funding proposals. Yet participants reported that implementation of AT elements within these policies has been minimal in Southern Africa.

Contextual policies that address AT are often stated as broad principles that require further technical guidance to facilitate implementation. For example:

> *States Parties shall take effective measures to ensure personal mobility with the greatest possible independence for persons with disabilities, including by:…b) Facilitating access by persons with disabilities to quality mobility aids, devices, assistive technologies and forms of live assistance and intermediaries, including by making them available at affordable cost; d) Encouraging entities that produce mobility aids, devices and assistive technologies to take into account all aspects of mobility for persons with disabilities. Excerpt from Article 20, (United Nations 2006)*

There is also a lack of consistency as to how AT is defined and embedded within the global and national contextual policies.

Contextual AT policies at the global level

At the global level several normative frameworks and plans contain the need for and/or right to AT. The first prominent global policy instrument that stated the importance of addressing AT needs was the UN Standards Rules of the Equalization of Opportunities for Persons with Disabilities (1993), though was not mentioned by interview participants. The UN Convention on the Rights of People with Disabilities (CRPD) was mentioned by a few participants and is frequently referenced in AT-specific international policy documents (WHO 2011, WHO 2018b). Adopted in 2006, the CRPD addresses AT within multiple article (Articles 4, 20, 26 and 32) – covering the promotion of research, development, production, availability and appropriate use of AT. While all countries in Southern Africa have ratified the CRPD except Botswana as of November 2019, the level to which this global instrument has been domesticated within national policies and practices is not known.

A few participants also mentioned the recent WHO initiative, Rehabilitation 2030 (WHO 2019b). Rehabilitation 2030 was launched in 2017 to address the growing unmet global need for

rehabilitation services within health systems. Increasing the rehabilitation workforce is viewed as central to increasing AT access, as stated in the Concept Note, p1:

> *Furthermore, access to appropriately trained rehabilitation providers is needed to realize the full benefits of the considerable growth in the development and availability of assistive products. (WHO 2017d)*

One direct service provider in Zimbabwe believed that this new initiative had potential to increase awareness about the importance of rehabilitation services:

> *They [WHO] say that rehabilitation services should be a part of essential health services, and they say we cannot achieve SDG #3 [Sustainable Development Goal] without rehabilitation. They are developing some working groups to come up with rehabilitation interventions, which is not happening is our country...I am hopeful that through that [Rehab 2030] many things will change, because the issue in our setting is more lack of awareness about rehabilitation services, the importance of it. (Direct services, government)*

Three additional international WHO policy resources developed in recent years were identified that make several references to AT:

- Global Disability Action Plan 2014–2021 has three objectives, one of which includes AT: *to strengthen and extend rehabilitation, habilitation, assistive technology, assistance and support services and community-based rehabilitation (Team 2014).*
- Global Strategy and Action Plan on Ageing and Health 2016-2020 includes five strategic objectives and AT is woven into all five (WHO 2017b).
- Towards Access 2030, WHO Medicines and Health Products Programme Strategic Framework 2016-2030, describes the importance of AT when considering the increase of NCDs and aging populations worldwide (WHO 2017f).

Most of the global contextual policies described above mention AT in broad high level goals that lack the technical guidance that is available for other health technologies. As a subset of health technologies, AT receives less attention than other types of products (i.e., essential medicines, medical devices) that have had substantially more investment from the global health community. While AT in needed within all sectors (health, education, employment, social, or political topics), most global instruments focus on the health sector. The CRPD is the only contextual policy tool at the global level, of those listed above, that places AT within a broader sector than health.

Contextual AT policies at the national level

At the national level most countries in Southern Africa have national disability policies and many of these policies explicitly address the need for AT (see examples in Table 6.7).

Table 6.7 AT addressed within national disability policies in Southern Africa

AT terminology	Domains that include AT
Lesotho (2011) - The National Disability and Rehabilitation Policy (Government of the Kingdom of Lesotho 2011)	
Appropriate assistive technological devices, appliances/ devices for PWDs, assistive devices, appropriate technology, equipment, adaptive equipment	• Social welfare and protection • Education and training • Economic empowerment
Malawi (2006) - National Policy on Equalisation of Opportunities for Persons with Disabilities (Malawi Government 2006)	
Assistive devices and support systems-Appropriate aids, appliances, technologies and other support systems that facilitate better functioning of persons with disabilities: adaptive equipment and assistive aids, information and communication technology, accessible materials	• Rehabilitation • Education and training • Economic empowerment • Information and tourism
Namibia (2004) - National Disability Council Act (Republic of Namibia 2004)	
Assistive devices, therapeutic aids, orthopaedic technical services, appropriate prostheses, orthoses, technical aids, Braille, large print	• Treatment, therapeutic aids and orthopaedic technical services • Employment
Zimbabwe (1992) - Disabled Persons Act (Government of Zimbabwe 1992)(amended 2001)	
Orthopaedic appliances, other equipment to disabled persons	• Rehabilitation

Table 6.7 displays differences in AT terminology and sectors (e.g. employment) that address AT. The oldest law, Zimbabwe (1992), has the most limited scope of AT while the more recent laws refer to a broader range of AT.

South Africa does not have a singular national disability rights law. As found in other countries, the rights of persons with disabilities are integrated within broader national laws (e.g., Constitution of South Africa Act (1996)(Republic of South Africa 1996), Promotion of Equality and Prevention of Unfair Discrimination Act (2000) (Republic of South Africa 2000), National Health Act (2003) (Republic of South Africa 2004)). What is unique about South Africa is that these stated rights have been developed into comprehensive disability policies that address the right to AT among other rights. Two recently developed national disability policy documents that address AT are presented in Table 6.8.

Table 6.8 South Africa disability policies that address AT

AT terminology	Topics/subsections that include AT
South Africa (2015) - White Paper on the Rights of Persons with Disabilities (Republic of South Africa 2015c)	
Assistive devices: Any device, product, equipment or tool that is designed or adapted to enable persons with disabilities to participate in activities, tasks or actions. They may include: (i) mobility aids such as wheelchairs, prostheses and crutches; (ii) Communication aids such as hearing aids, FM systems; (iii) Sensory aids such as white canes; noise reducing headphones and coloured lenses (iv) Technology aids such as computers for alternate and augmentative communication, screen readers, magnifiers, text in audio format. Assistive technology: It is an umbrella term that includes assistive, adaptive and rehabilitative devices and services for persons with disabilities, which enable persons with disabilities and learning differences to attain independence. They include for example, loop systems, sub texting and alternative input for cognitive assistance and computer or electrical assistive devices.	Pillars: • Removing Barriers to Access and Participation • Protecting the Rights of Persons at risk of Compounded • Marginalisation • Supporting Sustainable Integrated Community Life • Promoting and Supporting Empowerment of Persons with • Disabilities • Reducing Economic Vulnerability and Releasing Human Capital • Strengthening the Representative Voice of Persons with • Disabilities • Building a Disability Equitable State Machinery
Framework and Strategy for Disability and Rehabilitation Services in South Africa, 2015 – 2020 (Republic of South Africa 2015a)	
Assistive device or assistive technology: Describes any item or piece of equipment acquired commercially, modified or customised that is used to increase, maintain or help a person to perform a task or activity. Assistive technology: Assistive technology includes assistive devices (ADs) (such as mobility devices, orthotics, prosthetics) through to communication devices (hearing aids, as well as augmentative and alternative communication) , and medical products (all medical and surgical supplies that are consumables) excluding medication. Medical products include catheters, condoms, linen-savers, tape, wound-management materials (e.g. ointment and dressings) and Senokot tablets, required by an individual on a monthly basis to support independent living, a healthy lifestyle and maintenance of outcome level achieved prior to discharge from hospital	Level of care: • Primary Health Care Facilities (clinics, community health centres) • Hospital based services (district, regional, tertiary, central, specialized)

As expected, South Africa policies contain the broadest and most detailed descriptions of AT when compared to surrounding countries.

Given the focus on MOH and mobility devices during interviews, national health care laws were discussed most frequently among other national policies in relation to AT provision. Specifically,

participants discussed how MOH policies determined what types of AT were not covered and the lack of integration of rehabilitation services into primary health care and/or essential health services.

Other South African national policies mentioned by participants that may address AT access and supply included inclusive employment, inclusive education and accessible infrastructure (e.g., information, transportation, buildings). For example, government and for-profit employers fund AT for employees who qualify for 'reasonable accommodations'[11] such as modifications to the physical workspace or provision of accessible information technologies. One for-profit supplier discussed how they would advise their clients with visual impairments to seek employment with government agencies or large companies as these organization were more likely to cover costs and provide AT.

AT-specific policies

Most existing AT-specific policies identified by participants and located through documentation review operate within the health sector. AT-specific policies tend to be less aspirational and more implementable than the contextual policies. In this subsection, global and national AT-specific policies are described that include government and medical aid AT funding sources.

AT-specific policies at the global level

Multiple AT policy resources (standards and guidelines) have been developed by the WHO. These resources aim to guide the development of AT national policies, plans and programs. Most examples described below target the health sector and mobility devices, though there are plans to develop more technical guidelines for a broader range of devices.

- *Standards for prosthetics and orthotics* (WHO 2017e).
- *Guidelines on the provision of manual wheelchairs in less-resourced settings* (WHO 2008).
- *Joint position paper on the provision of mobility devices in less resourced settings (WHO 2011)*
- *Priority Assistive Products List (APL) (WHO 2016b).* The APL contains a list of 50 assistive priority products. The aim of the APL is to set a minimum standard of the range of AT products that governments should provide. The WHO plans to develop additional guiding documents (i.e., procurement policies) to facilitate implementation of the APL at the national level.

[11] Accommodations are "reasonable" as long as they don't impose "undue hardship" on the employer, and recent Court decisions have placed the burden on employers to demonstrate how providing accommodations will cause undue hardship (usually by compromising safety or jeopardizing the organization's solvency.) http://www.dpsa.gov.za/dpsa2g/documents/ee/2015/289_1_2_3_20_08_2015_Policy.pdf

- The WHO has also developed a vast collection of policy documents to increase and improve the supply, procurement and provision of a range of health technologies. The WHO catalogue of health technologies contains a series of publications that provide detailed technical guidance to inform national policies and programming, some of which also cover AT (WHO 2017c). For example, one publication lists available and prototype health technologies for low-resourced settings. This list includes medical devices, eHealth/mHealth, medical simulation devices, personal protective equipment, assistive products and other technologies. A prototype assistive product listed in the most recent list (2017) is a 3D printed prosthetics (WHO 2018c).

These WHO policy resources listed above have been developed by expert/technical committees, often involving a range of professionals and advocates across public, for-profit and non-profit sectors and representation from different geographical regions.

The most recent and possibly strongest global AT policy tool is the World Health Assembly (WHA) resolution 71.8 adopted in 2018 (WHO 2018b). The WHA is a decision-making body of the WHO comprised of a delegation of all members states. This resolution is likely to increase the visibility of AT among the development community and more carry more weight than other WHO AT policies because the process required support from member states. What is notable about the WHA71.8 is that it addresses AT across all major health and development sectors covered in the 17 SDGs, thus expanding the scope of AT beyond the health sector. It states:

> *Recognizing that the inclusion of assistive technology, in line with countries' national priority and context, into health systems is essential for realizing progress towards the targets in the Sustainable Development Goals relating to universal health coverage, inclusive and equitable quality education, inclusive and sustainable economic growth, full and productive employment and decent work for all, reducing inequality within and among countries by empowering and promoting the social, economic and political inclusion of all, making cities and human settlements inclusive, safe and sustainable, and providing universal access to safe, inclusive and accessible green and public spaces, particularly for persons with disabilities; (WHO 2018c)*

AT-specific policies at the national level

At the national level substantial AT policy-making and implementation has taken place in South Africa in the past two decades, again focused mainly on mobility devices within the MOH. Minimal AT-specific policy work has been done in surrounding countries with only a few examples provided by participants who worked in Namibia, Botswana and Zimbabwe. Across the region the lack of

regulations and subsequent enforcement at the national level has been identified as a key constraint in previous Figures (5.3, 5.4, 6.7) to ensuring appropriate products and provision.

National AT policy tools described below regulate government, non-profits, employers and medical aid companies.

Government AT-specific policies at the national level

Three types of AT-specific policy instruments developed for the South African public sector are described below. The first type is written as guiding principles (i.e., budgets should be based on local needs…). The second type are samples of detailed technical specifications used in the MOH tendering system. The third is designed to regulate public employers.

- The *Standardisation of Provision of Assistive Devices in South Africa: A Guideline for Use in the Public Sector (2003/2006)* presents a policy framework to ensure equitable and appropriate access to AT. This national-level policy document also include aims to regulate the behaviour of the non-profit AT providers or donors. It states:

  > *The recipient authority should establish a committee of relevant rehabilitation and personnel, both administrative and clinical, to manage the funds/donated AT.*
  >
  > *AT accepted, as donations should at least adhere to international and or the South African Bureau of Standards (SABS) endurance standards where possible and are appropriate for the South African environment (page 8) (Republic of South Africa 2007).*

- MOH tendering specifications: The two wheelchair policy documents described below that guide the tendering process were provided by one of the interview participants. While these documents focus only on wheelchairs, all AT products on tender will include these types of specifications.
  - *Technical Specification - Supply and Delivery of Wheelchairs, Seating Systems, Positioners and Commodes to the State for the Period 1 September 2014 to 31 August 2017:* 139 pages of product specifications including quality standards that are applied in public tendering.
  - *Special Conditions of Contract - Supply and Delivery of Wheelchairs, Seating Systems, Positioners and Commodes to The State for The Period 1 September 2014 to 31 August 2017:* 26 pages that described various bidding and contract regulations that apply to suppliers.

  As described in Section 5.3. on product supply, the tendering system in South Africa was reported to be an effective policy mechanism in increasing AT supply, appropriate provision

and sustained use. For example, under the tendering system there are policies that limit who can provide AT. As described by one participant:

> *In terms of accessing appropriate AT, in the state services at least there is a policy that says 'your wheelchair may only be prescribed by somebody that is trained'. In the private sector, anyone can set up shop. You can make a prescription as long as you are not saying you are a health care professional. (Direct service, for-profit)*

In addition, tender contracts contain extensive product requirements. As one supplier describes:

> *You have to be very competitive because it is the tender process. Products have to be durability tested, specific specifications that the tender demands. It's not easy. (Leadership, for-profit)*

- Employers AT-specific policies: One AT policy resource for employers in South Africa was located online. The *Policy on Reasonable Accommodation and Assistive Devices for Employees with Disabilities in the Public Service* reads (p. 12):

> *Departments are required to budget for reasonable accommodation and other measures for applicants and / or employees with disabilities, inclusive of the recruitment, appointment and retention processes. (Republic of South Africa 2015b)*

This policy explicitly states that public employers are responsible for AT procurement, repair and disposal and give examples of a range of devices that could be provided as part of reasonable accommodation (i.e., artificial limbs, hearing devices, prostheses, wheelchairs, white canes, dictaphone, computer with voice activation, note taker, magnifier, telephone typewriter and adaptations of physical workspace).

Medical aid AT-specific policies at the national level

As described in Section 6.3 Financing, policies for medical aid schemes often include the following parameters: preferred suppliers, products, prices and product replacement schedule. Minimum benefits can be established and enforced by medical aid regulatory bodies within each country that are created and authorized under national legislation (e.g., Medical Scheme Act). Yet participants agreed that AT is generally not included within these minimum benefit regulations and when there is some AT coverage it is inconsistently applied across schemes.

Furthermore, there are fewer assurances that minimum benefits include product quality standards or that these standards will be adhered to as procurement decisions can be made based on price alone. As expressed by one participant:

For persons in the private sector belonging to a medical aid scheme, procurement of devices is controlled by the various scheme rules. Some limit only the amount spent, others make use of preferred suppliers and/or cap the maximum amount, etc. The bottom line is price. No concerns about quality. (Direct service, for-profit)

In referencing back to Section 6.3 Financing, a few participants also reported that medical aid schemes rarely cover non-medical/health types of AT.

Trade and industry policies

As with other health technologies, AT product research and development, manufacturing and supply chain dynamics operate within the for-profit sector with the many AT suppliers targeting a global or transnational market. With the exception of South Africa where local manufacturing of select devices is well-developed, most AT products will cross national borders before reaching end users in Southern Africa. Thus, the international and transnational industry and trade policies play a major role in determining the cost and ultimately the availability of appropriate AT products.

This subsection will cover policies that were previously outlined in the Section 5.3 Product supply on international product quality standards.

Product supply policies

Policies identified previously that can cause supply chain inefficiencies include:

- Import/export duties: Duty exemptions have been applied for select product types or handled on a case by case basis but are not standard practice across a wide range of AT. As described (Section 5.3), Zimbabwe requires that importers/buyers apply to the revenue authority and/or ministries for duty exemptions for AT shipments, while South Africa maintains a blanket duty exemption policy for mobility devices. There was lack of agreement as to how pervasive AT duty exemptions were across with region, though mobility devices were more likely to be exempt than other types of products. One participant that worked with mobility devices across six Southern African countries (Zambia, South Africa, Mozambique, Zimbabwe, Malawi, Lesotho) stated the following about import duties:

  The good part is that governments in different countries have a system where if wheelchairs are coming in, they are duty exempt because there is no local capacity to make all those assistive devices such as frames, crutches, prosthetics. (Direct service, non-profit)

- Economic empowerment policies: Indigenization legislation designed to promote national economic development are common throughout Southern Africa (Das Nair and Chisoro 2016). Yet sometimes these policies added redundant intermediaries to the supply chain in

the Southern Africa region particularly when there is an absence of local manufacturing. Within South Africa, redundant intermediaries could result from BBBEE policies that are applied to national tenders (see Section 5.3). Two private suppliers that discussed indigenization policies stated:

> *All [countries] the moving that way. Botswana just chucked all foreigners. You're not allowed to have a business in Botswana unless you are a local Botswanan. Namibia also, you are only allowed to tender if you are a Namibian owned company. (Leadership, for-profit)*

> *Some countries don't want to deal directly with a South African company…They could get better prices if they went direct to the supplier, probably save themselves 20-30%. (Direct service, for-profit)*

- Restrictions on supplier behaviour: The absence of market entry and price mark-up policies (licensing) were also described as contributors to supply chain inefficiencies, as intermediaries with little or no expertise in AT are permitted to import and supply AT and can mark-up product prices without limits.

International industry standards

A few global industry standards were identified by participants that affect the quality, safety and accessibility of products coming into the region. Industry standards of companies with a large global footprint (i.e., Microsoft, Apple) influence select AT product characteristics. Specifically, the US legislation that covers accessibility of information and technology products must be complied with by all US-based ICT businesses. These standards have increased and improved accessibility features in mainstream ICT products, but these features are not usable by some people with disabilities. One participant described the accessibility level of the Windows 10 platform did not meet the need for many of their clients with low-vision:

> *There was a law passed in America that made every hardware and software company provide accessibility. But windows still today offer poor accessibility in their software. They offer it so by law they are ok but it is not usable. For example, there is a narrator that speaks and magnifying that zooms…yes, it magnifies but if you magnify 3x and above it pixelates your text, it's poor quality. It's blurred so it's not helping. My clients that need magnification work on 5, 6, 8x magnification so the built-in accessibility of Windows is not good. (Direct service, for-profit)*

The International Organization for Standardization (ISO) establishes technical AT product standards for a broad range of product categories, that are reviewed and updated every 5 years (International Organization for Standardization 2016). The 2016 ISO 9999 classification system includes 945 product titles that are classified according to function (e.g., AT for self-care activities). This

classification system aims to harmonize the AT sector globally. ISO standards are incorporated within practices of many national standard bodies in Southern Africa (e.g., Botswana Bureau of Standards) and part of product requirements for some AT products within in South Africa tenders.

AT policy structures, mechanisms and processes

Aspects of the AT policy development and implementation structures, mechanisms and processes within government, professional associations, medical aid schemes and non-profit organizations are described below.

Development of government AT tenders

Tenders for AT products and services are a primary policy mechanism for governments to regulate products, providers and provision standards. The design of tenders described included specific product attributes, standards on who can prescribe and provide AT, and local repairability requirements.

As presented in Box 6.1, the South African policy development process within the MOH was guided by committee with clinical and technical expertise, advocates and relevant government officials who are responsible for designing and revising tenders. As described:

> *Policy defines that wheelchairs need to go on a tender and all the categories (wheelchair types) were put in and that those categories had to have clinical and technical specifications, once that was done and put in place then every year has just been to improve it. (Direct service, for-profit)*

These wheelchair tendering specifications were first made within one province in South Africa that then spread to other provinces.

This model of establishing multi-stakeholder committees to identify product types and develop specifications within national tenders is now being applied to non-mobility types of AT and within ministries other than MOH. The detailed and technical process serves to identify the right types of AT product for certain types of disabilities within different sectors (e.g., employment). One participant described the process:

> *We were now with government on the tendering process to help facilitate the procurement of devices by recommending which devices for which disabilities can serve which purpose.*
>
> *Researcher: Which ministry?*
>
> *It's under the Department of Postal and Communication Services that oversees but there are many players in the workgroup. The workgroup was created and then we were invited as a supplier. (Direct service, for-profit)*

This same participant believes that the tendering product list and specifications would also be useful to buyers of AT that operate outside the public tendering system, such as private employers.

Piggy backing AT on to government medical devices regulations

Another strategy tried to regulate providers and products was to include AT (i.e., wheelchairs) within the well-established regulatory system of medical appliance/devices in South Africa. However, there was resistance from for-profit suppliers who wanted to operate without additional restrictions and thus this effort failed. As described by one participant:

> *There was recently a move to register wheelchairs as a medical appliance and that there needs to be regulation around that. And there was a push back from the supplier side because so many of them bring in products that don't adhere to standards. So, this is a conflict between user-rights, minimum standards versus having a viable business in South Africa. (Direct service, for-profit)*

National standards bodies

All countries in Southern Africa have a national standards body that is responsible for the quality assurance of goods and services. One participant described the regulatory role of the Botswana Bureau of Standards (BOBS) (http://www.bobstandards.bw/SitePages/Index.aspx) in certifying all suppliers and products, including AT. BOBS requires that all suppliers go through an extensive and lengthy evaluation process by a panel of experts and only those who receive certification can apply for government tenders. As described in Section 5.3 Product supply, this lengthy process was particularly burdensome for small companies (i.e., local AT manufactures).

The South African Bureau of Standards (SABS) is likely the only country in Southern Africa that addresses 'Accessibility & Disability' as a separate topic area. The website states:

> *SABS is a leading business services provider to organizations worldwide, offering a range of services for management system certification, product testing and certification, and standardization.*
> *This includes the standardization in the field of Accessibility & Disability including all aspects of their effects on man and his environment relating to activities in the following fields: accessibility to ICT for persons with disabilities & elderly, escalators and passenger conveyors, assistive products for persons with disability, assistive mobility devices for persons with disability, universal access and universal design in the built environment. (South African Bureau of Standards 2019a)*

Thus far, SABS AT-related publications cover lifts for persons with disabilities, adaptive vehicles, ergonomics, information technology and national building regulations (South African Bureau of Standards 2019b). The Accessibility and Disability section within SABS was the only governing body

focused on AT standards in Southern Africa that was identified through this study. Note that this entity was not mentioned by interview participants, most of whom worked in South Africa.

South Africa also has the South African Health Products Regulatory Authority (SAHPRA) that is responsible for regulating health products including 'medicines, medical devices, in-vitro diagnostic tests and devices, radiation emitting products and devices used in health care and industry' (South African Health Products Regulatory Authority 2019a). Based on the information available through the SAHPRA website (https://www.sahpra.org.za/), AT products are not within their purview as of December 2019.

Professional associations

Another avenue for AT policy development and implementation is through national professional associations that are responsible for standards in training and practice, including registration of professional within a specific discipline (e.g., occupational therapy). These associations establish the scope of practice for each AT-related profession. When an AT product is provided by professionals across multiple disciplines or non-professionals (i.e., pharmacies), a new product and practice standards require negotiating among all the relevant associations.

> *There is a gray area. Pharmacies are selling crutches as well and what is the worst that can happen with crutches? It's really about creating a clear definition about what is acceptable to supply to the general public and what is not. Where we [professional association] are heading is to have products categorized to levels 1-5. Let's say crutches would be a level 1 and a calipher [leg brace] for someone who has polio would be a level 5. And if you're not certified to provide a level 5 product then you have nothing to do with that product…The route we have to go is to the health professional council and then each association like the pharmacy association, the physio association and occupation therapy association - everyone has to agree to those. (Direct service, for-profit)*

Within the health sector, alignment is needed between standards developed by associations and by the national professional health councils that register and regulate all health providers and facilities such as the Health Professionals Council of South Africa (HPSCA). The HPSCA covers a range of rehabilitation disciplines including prosthetics and orthotics, occupational therapy, speech language therapy and physiotherapy (Health Professionals Council of South Africa 2019).

National associations in Southern Africa are also affiliated with international bodies that are tasked with harmonizing standards, among other roles. Examples of international professional organizations within the AT sector include American Speech Language Hearing Association, International Society of Physical & Rehabilitation Medicine, International Society of Prosthetics & Orthotics and World Federation of Occupational Therapist.

Medical aid

In many Southern African countries medical aids schemes are regulated under national legislation that is implemented by a medical aid regulatory body (e.g., South Africa - Council of Medical Schemes, https://www.medicalschemes.com/; Namibia - Association of Medical Aid Funds, http://www.namaf.org.na/). These bodies aim to support the medical aid industry and ensure medical aid consumers are protected and receiving value for their privately paid plans. Prescribed minimal benefits that all schemes must comply with are a key component of these regulations. As described earlier, minimal benefit regulations have inadequate coverage of AT.

Non-profits

A few examples were described where international NGOs engaged in AT policy development in collaboration with the MOH. One participant that worked for an international NGO that is prominent in the disability field discussed how their AT provision required national policy development within the countries they served. As described:

> *While we were working on the provision of wheelchairs, we discovered that unless it is underpinned by a policy in each country then there is incoherent. Not only from country to country but within the country itself. We were looking at how to form structures within the national level to look at policy issues, that involved government and other stakeholders.*

They continue to explain the need for policies to cover a broader range of AT:

> *If we are to think about policy that policy needs to include hearing aids, walking frames, white canes and all the other devices. (Direct service, non-profit)*

In Zimbabwe, a committee was initiated under the MOH as part of a USAID funded project but did not sustain long enough to develop policies. The primary aim of the committee was to increase the quality of AT products provided within the county. One participant described why the committee was unsustainable:

> *At some point we did advocate for a committee to be place under the department of social welfare. They wanted to name it the assistive devices committee and there were Terms of Reference, but this was pushed through the USAID funded project but it never took place. It was always 'who is responsible, which ministry' no one wanted to take ownership of it, but this would have made a huge difference. (Leadership, non-profit)*

Challenges to strengthening AT policies

In the previous sections, the lack of regulations/enforcement was identified as a contributing factor to inappropriate AT, poor quality AT services and supply chain inefficiencies (see Figures 5.3, 5.4, 6.7).

The lack of regulations allows for untrained/unqualified individuals to retail AT devices of varying quality through a variety of channels (e.g., pharmacies). As described by one participant from Zimbabwe:

> *There are more business minded people getting into this [AT]. The major problem is the system around AT. Within the context of Zimbabwe there is no system that safeguards…so it is prone to people being opportunistic. You find an opportunity, 'oh I can make money selling crutches'. I found crutches being sold in a convenience store right next to the gas stoves (Direct service, government).*

A commonly reported issue is that a range of AT products can be sold by pharmacies with or without appropriate services. South Africa is working to set policies that would limit the types of products provided by pharmacies. As described:

> *What we see more happening nowadays is that these products, like off-the-shelf bracing are being sold by your local pharmacy. I would say that has been a major change in the evolution of our industry. As orthotists and prosthetist in the country, this type of product was formally only available from a practice and clearly the manufacturers have realized that there is this huge gap to fill in the market, e.g., people who don't have medical aid or don't have access to an orthotist they go to their local pharmacy. And we as an association are really trying to create more rigid boundaries as far as what is in the scope of practice of orthotist and what is the scope of practice of a pharmacist…Unfortunately people are being advised as to what type of wrist brace or knee brace might be of benefit to them by a pharmacy floor assistant who really doesn't understand the anatomy at all. (Direct service, for-profit)*

Regulations are also not in place to delineate the scope of practice of different types of AT professionals. As another participant reported:

> *The problem is that the field has been invaded by other professionals, like the physio, the tech, etc. They also sell them [orthopaedic AT] where they are. It is not confined to orthopaedics. We have others playing in the field that are not orthopaedic professionals. (Direct service, for-profit)*

Efforts to develop and strengthen AT policies to facilitate the increased supply of and access to appropriate AT products and services within Southern Africa face numerous challenges. Many of the key challenges outlined below are interrelated.

Lack of conceptual uniformity

At the most fundamental level, conceptual inconsistencies pose a challenge to advancing policies within the AT sector. Definitions, scope and taxonomies of AT differs across global and national policy instruments. As found in Study 1 (Chapter 3), the lack of shared common frameworks also impedes the AT research field. The international standards (ISO) AT classification system is one potential unifying tool.

Complexity of AT products and providers

The regulatory requirements vary by product types and the broad range of products, product characteristics and associated services make developing, implementing and monitoring regulations highly complex.

High level policies lack technical guidance

Most contextual and AT-specific policies described in this section operate at a high level and are not actionable without greater technical guidance. These policies have been used to pressure governments (member states) and other key actors in the global development community to prioritize AT. Yet without lower-level policies needed to guide policy design, implementation and monitoring, the increased priority level of AT does not translate into increased supply and access. Most actionable tools developed thus far have focused on mobility devices within the health system (e.g., WHO Wheelchair Training Packages).

WHO GATE plans to develop technical guidelines that mirror those developed for other health products. The Essential Medicines and Health Products Information Portal currently contains over 400 resources categorized under the topic 'health products' and many provide detailed specifications of safety and clinical standards of practice (WHO 2019d).

Lack of uniform standards

There is also a need for more unified product, procurement and service standards to increase quality and reduce complexity of the AT sector. This lack of uniformity is found within and across government, for-profit and non-profit actors; by country; and even individual facilities. Harmonizing product and procurement standards will reduce the burden faced by manufacturers and suppliers who are working to meet different standards, and help address supply chain inefficiencies (e.g., lack of bulk buying, redundant intermediaries).

South Africa has developed their own quality and testing standards for at least a few product categories to ensure products are appropriate for their context (South African Bureau of Standards 2019b). To reduce redundancies, standards established can be shared transnationally and even globally when relevant to the Southern African context.

Large free market

The lack of AT regulations coupled with poor economic conditions has allowed a vast number of intermediaries to enter the market without AT expertise, often offering substandard products and services. In general, both companies and end users are motivated to expand the unregulated AT market. The business company see the huge unmet need as a growing opportunity and end users are often willing to settle for something suboptimal/inappropriate instead of nothing. Without an adequate supply of appropriate AT, regulating the inappropriate products and providers is not possible, as expressed by one participant:

> *The biggest problem is that government doesn't have resources. You can only start to enforce regulations when you have the capacity to provide locally. But if people can't find wheelchair at local hospitals then you can't regulate, unless you have also addressed the supply side. (Leadership, non-profit)*

Lack of implementation

In South Africa where the AT sector is the most advanced in the region, the national AT standards developed in 2007 have yet to be fully implemented (Republic of South Africa 2007). These standards are written at a high level and fail to identify the role of responsibilities of government entities or officials in implementation. As shown in Table 6.9, many of the AT sector problems identified in this study were mentioned in this standards document developed over a decade ago.

Table 6.9 AT sector issues and corresponding excerpts from Standardisation of Provision of Assistive Devices in South Africa

AT sector problems	**Excerpt from *Standardisation of Provision of Assistive Devices in South Africa (Republic of South Africa 2007)***
Lack of data on unmet need	Budgets should be based on local needs…
Lack of funding for spare parts and repairs (e.g., lack of sustained use)	Wherever possible, service tenders should stipulate that suppliers include the prescribed device or assistive device package, (e.g. hearing aid, ear mould, starter pack of batteries), as well as after issue maintenance and repair...
Lack of information systems to track AT	A standardized record system of AT that are prescribed, issued, repaired replaced and recycled must be kept to facilitate budgeting.
Unqualified providers issuing AT	Assessment and prescription for AT shall only be done by appropriately trained rehabilitation providers…
Product selected based on price not clinical needs	Prescriptions should not be altered by any person/s (e.g. Administration Clerk) responsible for ordering or administration of AT
Lack of AT skills in new graduates	Newly trained graduates should be specifically trained in the issuing of AT…
Long wait of end users	AT should be issued immediately when prescribed or, at the latest, on discharge.
Inadequate supply	For bulk buying care should be taken that adequate numbers of different sizes of AT and the relevant spare parts are purchased.

Lack of AT governing structures

Lack of governing bodies that focus on the AT industry at the national or transnational level contribute to inadequate and incongruous standards, and lack of policy implementation. When many participants spoke about AT regulations there was little discussion about how these regulations are developed or implemented. There was a general understanding that 'government' was responsible for AT regulations, but no specific governing entity was identified that focused on the AT sector. Existing and mostly inadequate AT regulations have arisen from several separate policy making and governing structures, often fragmented by AT type, sector and/or professional discipline (e.g., prosthetists). The effort of an externally funded international NGO to establish a policy making committee was not sustained as it was not adopted government. The one exception to the lack of AT government structures was found in South Africa. The SABS Accessibility and Disability section does include select AT products.

Strategies to strengthen AT policies from the perspective of participants

Government tenders as a potential comprehensive policy instrument

A policy instrument that has potential to improve product and service quality, address supply chain inefficiencies, and increase quantity and consistency of supply year to year are national tenders. The South African government has developed MOH tendering policies for AT and is beginning to expand policy development to non-mobility devices (e.g., sensory) and to other relevant ministries. MOH public tenders for mobility devices have served to expand range of devices available, increase product quality, and help ensure repair and replacement parts are provided. Clinical and technical expertise was required to develop detailed tender specifications, which then must be revised periodically to respond to changing population needs and product innovations that become available. However, in some cases tenders have favoured redundant intermediaries over direct and full-service suppliers due to economic empowerment policies.

Successful implementation of tendering policies depends on training and awareness raising, particularly among direct service providers. The importance of training direct service providers and relevant officials was described by one participant:

> *You may also have problems, for example, you have the tender so you prescribe an active wheelchair. Then at the administrative level where the order in placed, your procurement department says 'why would I want to buy a 3000 Rand wheelchair when I can get a 1800 wheelchair, which is your basic folding frame, so I'm just going to buy that' irrespective of what is prescribed…Those things are getting fewer as the therapists/service providers become more empowered and understand their rights, they have knowledge of the policies. The policy says that*

only a trained service provided can prescribe and no administrative officer may change the prescription on any grounds, so there is a lot of protections built in. (Direct service, for-profit)

Tendering policies, if well-designed, can address challenges within the procurement and provision system. Specifications may include service requirements such as product warranties or other post-sale services, pricing guidelines and purchasing of spare parts. As shown in the quote above, tender policies can also specify who is permitted to prescribe certain devices (i.e., direct service provider). If prescription policies are adhered to during the procurement process, the product should be appropriate for the end user and the environment.

Trade and industry policy solutions

Supply chain policies that were recommended included duty exemptions and modifying the application of economic empowerment policies to reduce the number of redundant intermediaries in the supply chain. For example, if a country lacks the option of locally manufactured AT, which is the case in most countries outside of South Africa, the government should purchase directly from South Africa or international manufacturers to decrease cost and increase likelihood of receiving post-sale services. One participant suggested that these supply chain related policies should be designed and implemented throughout SADC, including duty exemptions and arrangements that increase supply chain efficiencies and product quality, especially to promote regionally manufactured AT, stating:

The governments need to reduce duty on outside products that are not locally available. Government needs to come up with incentive for local AT suppliers. Governments should remove duties for regional manufacturers… and needs to set the standards for the warranty, for 2 or 1 year, so products are made of quality. (Leadership, for-profit)

Duty exemptions should be applied for all products classified as AT, instead of reviewed on a case by case basis by shipment or product category (i.e., eye glasses).

Regulating market entry and behaviour such as price mark-ups of suppliers of AT could also reduce costs and increase product quality. Regulatory details need to be specific to each product category depending a service requirements and level of risk.

Developing uniform product, procurement and provision standards

Aligning procurement standards across relevant government departments, for-profits and non-profits, would greatly reduce the levels of fragmentation and complexity in the AT sector. While many standards will be segmented by product categories or types, some high level criteria can apply

to all types of AT such as ensuring services and parts are included to maximize the full product lifespan. Harmonization of other key policy elements may include:

- List of approved suppliers that cover a broad range of products
- Product quality standards
- Process for reuse/recycle

Furthermore, differentiating AT products by level of risk to end users and need for professional services would simplify the regulations. Products that are safe to be offered off-the-shelf without services or training at a pharmacy or other retailer can remain unregulated, while detailed regulations would be created for products that require trained providers or specialists.

Harmonizing policies across Southern Africa

Policy solutions developed to regulate AT products, procurement and provision can be shared and implemented transnationally to facilitate growth in the AT market across Southern Africa. One participant mentioned how South African wheelchair tendering policies were shared with MOH within a few neighbouring countries to accelerate their policy development process. Collaboration among national professional associations and other professional AT-related networks in the region were described as another regional harmonizing strategy by another participant:

> *Normally what we do, because we have a prosthetics and orthotics association, we play with other association in other countries, we have to align, toe the same line, sing the same tune, we have to align everything. It's a global village. We can't operate in isolation. In Africa we also have FATO [African Federation of Orthopaedic Technicians], it caters for P & O services, and then we have ISPO, worldwide organization and we are members. (Direct service, for-profit)*

Uniform AT policies mandated by regional harmonizing bodies can shape behaviour of governments, medical aid schemes and non-profits. SADC was mentioned as one of the influential transnational policy making bodies that can facilitate this process of harmonizing AT policies across Southern Africa.

Synopsis of AT policies building block

The need for and right to AT has been embedded within global policy instruments for decades and only recently has AT been elevated to the central topic (WHA71.8) (WHO 2018b). The WHA71.8 addresses AT across all major health and development sectors covered in the 17 SDGs, thus expanding the scope of AT beyond the health sector.

As the case with global contextual policies, national disability policies address AT in broad principles that are often not paired with actionable tools to facilitate implementation. The technical

instruments developed thus far at the global level have been primarily limited to mobility-devices within the health system.

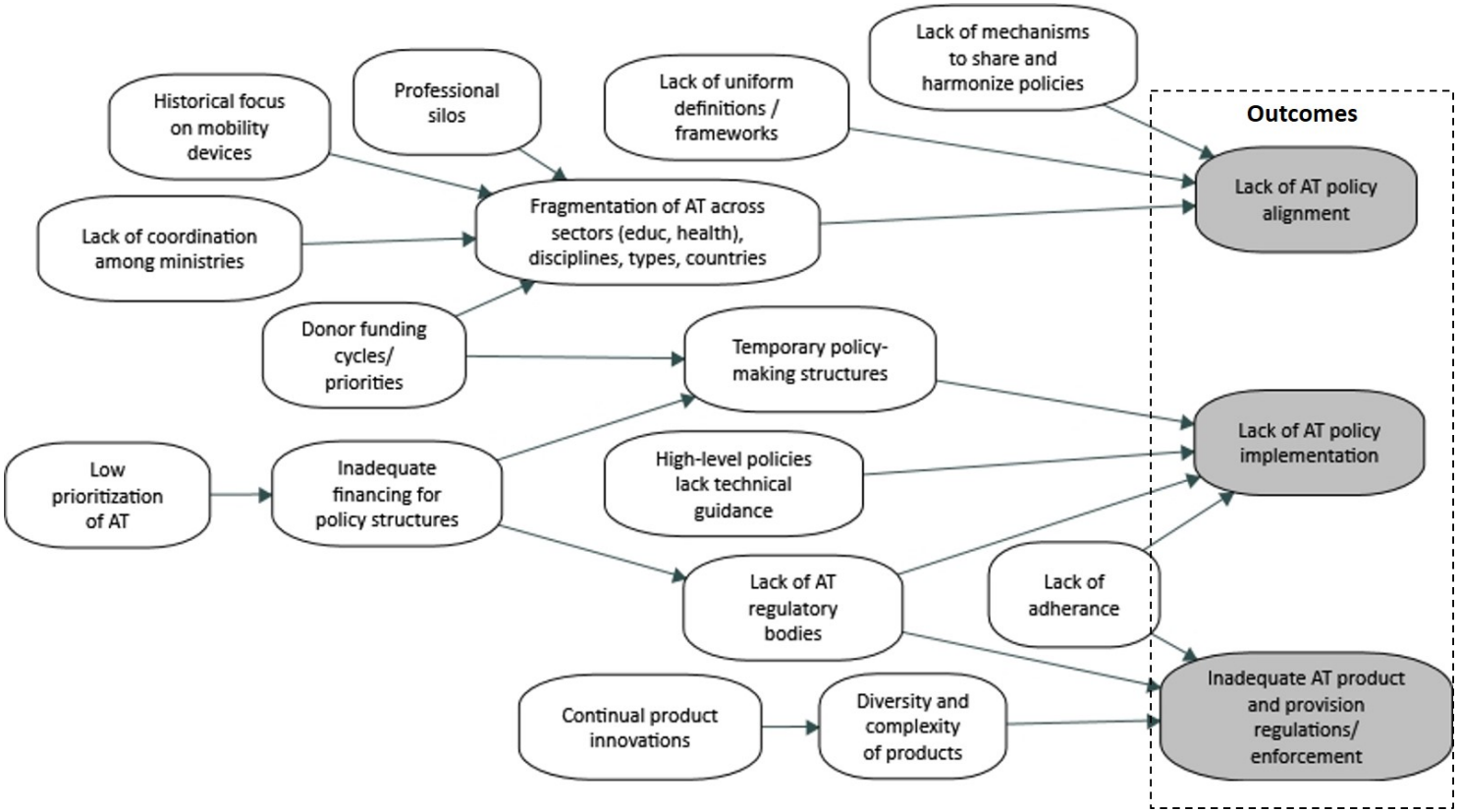
AT-specific policies have been implemented in a piecemeal fashion in Southern Africa with most advancements taking place in South Africa within MOH. This fragmented approach reflects the segmentation in the sector across different types (e.g., wheelchairs, hearing aids), professional disciplines, ministries and sectors (government, non-profit, for-profit). The lack of uniformity in AT policies, along with the absence of national or transnational coordinating/regulatory structures that focus on AT pose major challenges to reducing fragmentation. Underpinning all the policy making and implementation challenges is the lack of financial resources devoted to policy design and implementation work.

As shown in Figure 6.9 the key characteristics (outcomes) within the policy building block are 1) inadequate AT product, procurement and provision standards, 2) lack of policy implementation and 3) lack of AT policy alignment. The underlying factors that contribute to these outcomes arise within all three sectors (government, non-profit and for-profit). The inherent complexity of AT (i.e., range of products and characteristics, diversity of service requirements) puts an additional burden on policy development and implementation.

Multiple regulatory authorities and professional associations were identified in South Africa that play a role in establishing and enforcing product and service standards. Yet it is not clear as to which product categories are within the scope of each governing body or how these different bodies coordinate policy efforts. The dedicated unit to Disability and Accessibility within SABS may be a promising model for other countries to follow.

In addition, government, medical aid and non-profit AT policies require greater uniformity. Some policy elements would be best addressed globally (e.g., AT taxonomy) while others may need to be crafted at the transitional or nation level (e.g., preferred suppliers). Differentiating which product types don't require regulations could help balance the competing need of the free market and consumer protection as 'unqualified' suppliers could then target product categories that do not require regulations.

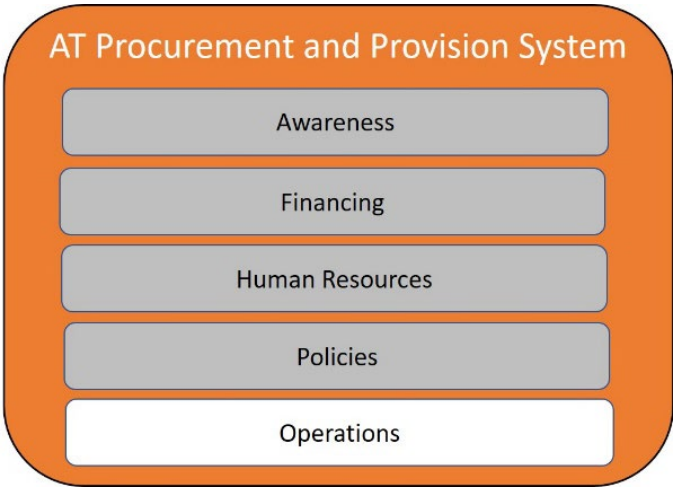
Figure 6.9 Policies building block: Outcomes and contributing factors



6.6 OPERATIONS

Operational inefficiencies described in this section cover a few bottlenecks in the procurement and provision system that delay or prevent an end user from obtaining appropriate AT. These types of daily procedural inefficiencies were only discussed by a few participants though it is expected that they account for extensive product delays and reduced supply. Figure 6.10 highlights the final building blocks discussed among the research findings.

Figure 6.10 AT procurement and provision system: Operations building block



The types of operational inefficiencies described in this section include bureaucratic processes, poor budget management, in-house administrative policies and practices, and the lack of information systems. Most inefficiencies participants described pertained to the MOH tendering system in South Africa, with a few examples provided about the medical aid system.

MOH procurement and provision operational challenges

Within MOH, AT products and related-services are procured through the tendering system. As previously described, the way the tendering process has been designing and applied in South Africa has resulted in increased quantity and range of AT products (i.e., wheelchairs). However, operational challenges identified by participants reduced timeliness of receiving products and could compromise quality and appropriateness of AT procured. These challenges are described as due to bureaucratic processes and poor budget management.

Bureaucratic processes within MOH procurement

A few participants described an overly complex bureaucratic process for ordering and purchasing AT which often resulted in significant product delivery delays. One direct service provider who worked

at a public hospital described the time intensive process for ordering AT and other rehabilitation supplies:

> *…We had to get three quotes for every item and each supplier had to have a government supplier number for the Eastern Cape. If they didn't have it [supplier number] we couldn't use them. Basically, it was a big paper chase. Each quote was only valid for 3 months so if you were delayed on getting any of the quotes or the procurement meeting was delayed as well, by the time you got there the quotes had expired and you couldn't present it so you had to start again. So, you get the new quotes and you get it all together and you take it to your procurement officer and they might sit on it, might lose it, might find problems with it and send it back to you so it's the paperwork process. Even once it had been agreed at the hospital procurement meeting, there is no end to the things that could theoretically go wrong. So, it was an endless paper chase. It ate up days and weeks of my life that I will never get back. (Direct service provider, government)*

Another direct service provider in South Africa described similar inefficiencies in the procurement process:

> *If the supplier is on tender, first you get a million signatures on your little order then it goes through cash flow, which is a hospital meeting that either awards you or doesn't the permission to go ahead with purchasing. They may slash your numbers just on a whim as well. Then it goes to stores department where someone writes in down in a A4 spiral notebook…then it gets lost, usually. So that's when you have to go and find it so it's important you keep your own records…then at some point in time someone might get to pushing it further. If it's not on tender it has do go through valuation and award committee so that is another 3 months. That is why we want things on tender.*
>
> *That and we get cheaper prices. If on tender it will proceed through the procurement process in which case it will go through about four different small offices with well-meaning but not very competent staff, and it could get lost at any point in that process as well, until it reaches procurement office. They will phone through to the supplier, probably fax the order although they are slowly moving to email now. Then it will go on to the central supplier like CE Mobility, a big wheelchair company…Then they [CE Mobility] will check to see if your stores department is up-to-date with payments which often they aren't, in which case no one will be the wiser that they did not release the order until the therapists realized the thing has not arrived yet and phones the company. (Direct service provider, government)*

When AT products are not already listed on tender, the process of ordering and receiving this off-tender product is even more laborious and can delay the receipt of ordered products by more than a year. As described by two direct service providers:

Just getting the foam to do basic adaptations [of wheelchairs], I think that took me two or three years because I couldn't find a supplier that had a government supplier number. Shame, this one company went through the whole process to get the supplier number…It was a whole run around…One of the problems is that things like that [foam] are not on the tender. The national tender didn't include things like spare parts or cushions. (Direct service provider, government)

The national wheelchair tender is really detailed. It's not bad. What they need to make sure happens on that one is to make sure that all the spares are included in the tender so that you can buy spares on tender instead of off-tender because that is a complete nightmare and money wasting exercise. (Direct service provider, government)

The exclusion of spare parts for AT products on government tenders was identified as a major obstacle to the sustained use of AT. A direct service provider gave another example:

What happens is, the person just needs to replace the ferrules [rubber part at bottom of crutches] but the hospitals can't get the ferrules so they give him a whole new crutch. So, you walk into a therapy department and there are stacks of crutches still in perfectly good condition, they just don't have ferrules. It's massive waste of budget. (Direct service provider, government)

Spare parts, when available, are often not distributed to lower levels within the health care system such as district hospitals or community clinics. When end users must journey to the tertiary hospital for spare parts or repair, this creates yet one more barrier to sustained use, particularly for people in rural areas or lacking transport. A story in Box 6.2 described a rural person's experience in trying to access spare parts.

Box 6.2 Ferrule Story: Lack of access to spare parts for AT in rural South Africa

The following is a summary of data presented in a doctoral thesis published in 2016 that focuses on one person's experience of trying to get spare parts (i.e., ferrules) for crutches (Sherry 2016). Doctoral research involved interviewers and observations with people with disabilities in a rural area of South Africa. This story is about one man trying to replace ferrules. Ferrules are the rubber or plastic stoppers placed on the bottom of crutches to improve comfort, safety and stability while walking.

An active man who is the head of the household requires crutches to move around due to a low limb injury sustained during childhood. He is a leader in his community, works as a carpenter though job opportunities are inconsistent, and walks long distances with his crutches for work and other activities. Ferrules can be worn down within a few weeks given the low quality of the ferrule and the amount he walks. A major challenge for him is getting replacement ferrules for his crutches and without ferrules he experiences physical pain (hands, back, arms) that is so bad he has trouble sleeping.

The process of getting new ferrules is cumbersome and time-consuming, even though ferrules costs less than R20 ($1.50 USD).

Typical steps in this process of trying to access ferrules include:

- Transporting to district hospital and standing in line to find out they do not have ferrules in stock.
- Given an appointment with physiotherapists at district hospital who makes appointment for him at the tertiary hospital.
- He books seat on hospital transport which is often overbooked. He has to arrive the day before and sleep on the hospital waiting room benches to be seen in the morning.
- He then receives a single set of ferrules and travels back to his home.

While he is away going through the lengthy process of obtaining ferrules, he loses earning potential and worries about the safety of his family. He has asked for ferrules to be shipped to the district hospital when pharmaceuticals are delivered but has had no success.

Therapists at the district level also are not able to purchase and obtain ferrules because there is nowhere to buy them locally (e.g., Clicks pharmacy) and the health system is not providing them. For this reason, therapists often provide a new set of crutches, which are easier to obtain than ferrules, and the crutches without ferrules go into the abandoned pile of AT.

Poor budget management within MOH

Participants reported that payments to suppliers for AT products made by the procurement office may be delayed or not paid. This backlog of payments combined with poor accounting practices can reduce the AT budget available in the future. As described by one participant:

> *After I left [the position at a state hospital] I had suppliers phoning me saying they haven't been paid for what I ordered three years ago. So that was a big problem…Because payments don't get processed, accruals build up at the beginning of each financial year. Soon as the new budget comes in, it looks like you have money for x, y, z but the accruals from the previous year first need to be paid. So, the money gets eaten up before it's there and sometimes I think money is taken from one budget to pay another. (Direct service, government)*

Another budgeting problem described was when budgets are withheld and then suddenly released. This can result in large hospitals placing bulk orders and smaller hospitals/facilities having to wait for AT orders from suppliers as large orders take priority.

The table below (6.10) displays broad steps within the MOH procurement process beginning with direct service providers selecting the suitable AT products for the client (Step 1) and ending with the supplier delivering the product (Step 4). This table provides a generalization the operational challenges with procurement based on descriptions of the MOH tendering of mobility devices in South Africa. All operational bottlenecks are on behalf of the government practices and not that of the AT suppliers.

Table 6.10 Operational bottlenecks within the MOH procurement process

Steps in procurement process	**Operational bottlenecks**
Step 1: Direct service provider selects AT product	• Multiple signatures required at facility-level • Lost or stuck paperwork
Step 2. Procurement officials approve order and send to supplier	• Infrequent approval meetings • Approvals required from multiple offices (note that approval process is lengthier for off-tender products) • Lost or stuck paperwork
Step 3: Supplier processes order	• Outstanding balance on previous orders • Direct service provider not informed of insolvency issue
Step 4: Supplier delivers order	

It is important to mention that these types of procurement challenges of getting orders approved and processed are not necessarily unique to AT and may be pervasive across a range of health products and services that are procured through the public health systems. As stated by one participant:

The delay is not a logistical issue, it's the processing. Once it's all been agreed the orders go through…The delay is getting everything agreed and getting the department to process the order itself…This affects all aspects of the health system. You fix procurement and I think you would have a much happier health system. (Direct service, government)

Inadequate information systems to facilitate MOH procurement and provision

Three types of AT information systems were identified as lacking or inadequate within MOH:

- AT procurement data system: An information system is needed for expediting and tracking all steps along the procurement process. The lengthy journey from ordering to receiving a product is primarily a paper-based system that is prone to delays (e.g., lost documents). An electronic information system could expediate the procurement process and provide transparency on ordering status and procedural or staffing bottlenecks.
- Client management: Information systems are needed to monitor clients and products. One participant described the type of AT information system that is needed:

  So, what we desperately need is an electronic AT monitoring system, like log system where information flows both ways. As I issue the device, I log the patient details, link it to the ICD-10 code, put the device in, and follow up appt. That follow up appt. needs to pop up at the end of the month so you can track. And some of that info would have to go to district and some of province and even less up to national. I would need to be able to pull all of my inputs for that month or year and be able to sort by own data at the bottom. So, it needs to be user-friendly at the bottom as well give the guys at the top their stats (Direct service, government).

- AT product inventory tracking system: Another information gap identified was the ability to track product inventory, what is in stock and has been issued to clients. This is particularly important for equipment that is loaned for temporary use. As described:

  We have no idea what audio equipment is sitting whereas we have no equipment asset register. (Direct service, government)

  An electronic data system was being used to track inventory of HIV medicines in South Africa in order to flag stock outs. One participant thought this type of system is also needed for AT.

Medical aid procurement and provision operational challenges

In-house administrative policies and practice are specific to each medical aid company and can cause operational challenges. Specifically:

- Pre-paying for AT: When AT is covered by a medical aid company the provider or the client may ned to pay for the AT product upfront and then get reimbursed. This can cause a bottleneck when providers or clients do not have adequate funds.
- Medical bias: Medical aid schemes that require medical prescriptions make it difficult for non-medical types of AT to be covered such as a digital magnifier for a person with low vision. As described in Section 6.4 Human resources, this medical bias also results inadequate training for direct service provider on the broad range of AT possible.
- Unlisted AT products: When a prescribed product is not already on the medical aid list of approved suppliers and products, the process of getting this new product approved and registered is time consuming. This final inefficiency mirrors ordering off-tender products and parts through the public system. One for-profit provider described the process of getting a new product registered and coded.

  We have a company, [name], which is an independent organization…They are appointed by our association, the South African Prosthetics and Orthotics Association. So, they appointed this independent body that all suppliers have to work through the get their products coded and obviously you pay a fee…When we register the product, we have to provide CE certification [product safety certification] of the product and clinical indications. That information is then made available to the insurance companies so they can see if it is a certified product and this is what the code is. (Supplier, for-profit)

  The onerous nature of getting new products registered and then covered by medical aid companies limits the range of products and is an obstacle to getting new product innovations covered.

Strategies to address operational challenges from the perspective of participants

Direct AT procurement by service providers

In Zimbabwe and lower resourced provinces within South Africa, direct service providers can have a more direct relationship with suppliers and manufacturers and fewer bureaucratic hoops to jump through to get AT ordered and delivered. For example, a hospital in the Eastern Cape did not have a stores department with a procurement official to order and stock AT products so an occupational therapist was able to place the order directly with the supplier on tender. Likewise, in Zimbabwe one for-profit rehabilitation professional could order directly from any global manufacturer without going through a regulatory body. This same provider acknowledged that lack of AT regulations was also allowing non-professionals to bring in inappropriate products. This model of given direct service providers direct access to suppliers was not recommended by a one direct service provider as it

lacked the checks and balances to ensure purchasing decisions were congruent with AT facility budgets and did not allow for corruption.

Pre-stocking suboptimal AT

One creative method is to make a bulk order for folding frames chairs to carry as stock so that patients have something at time of assessment that they can use until their prescribed wheelchair arrives. One therapist describes the process:

> *Because budgets are so erratic, people [therapists] don't assess the patient first and then order the AT they need and go procure it because then the patient might get the chair in eight months' time. So, what most people are doing is procuring the standard folding frame 'el-cheapo' wheelchairs as stock. As the patient comes in, you seat the patient as best as possible in one of those folding frames and at the same time you are ordering them their specialized chair that they actually need. (Direct service provider, government)*

AT reuse programs

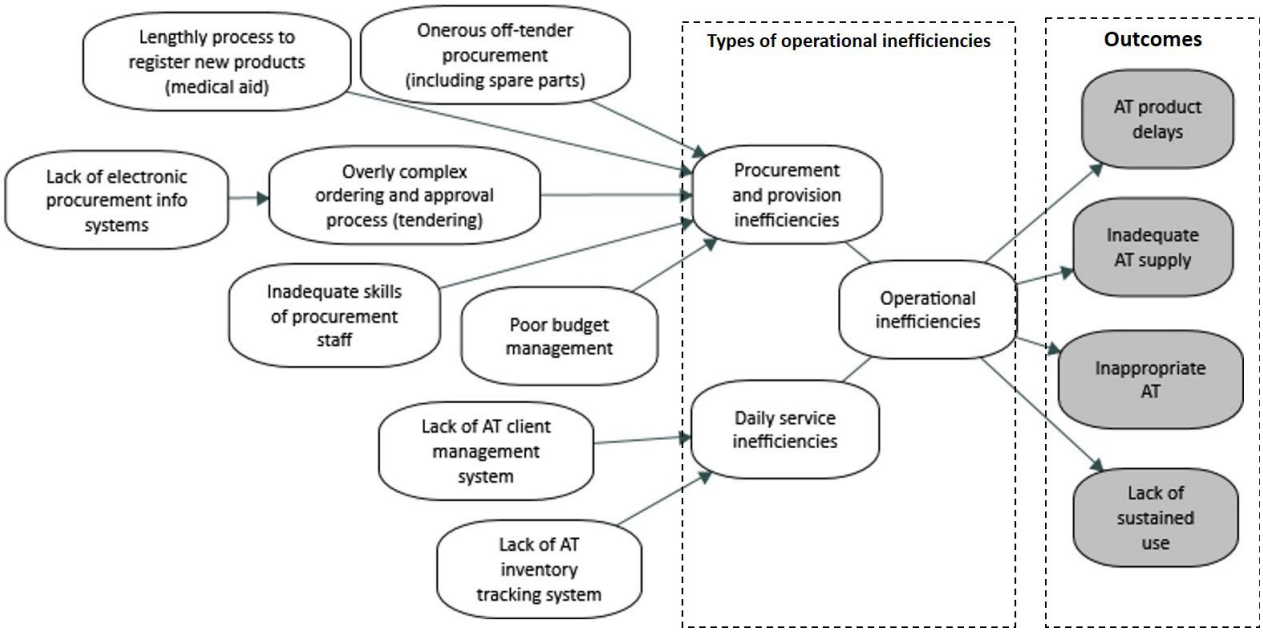
As described previously in Sections 5.2 and 5.3, reusing AT products can circumvent the complex and slow process involved when procurement new products. Yet when the refurbishment requires new spare parts, the turnaround of reused products can be just as time consuming as with new products.

Synopsis of operations building block

Operational inefficiencies are grouped into problems with 1) procurement and provision and 2) daily services. The overly complex processes combined with inadequate staff capacity/skills and lack of information systems all contribute to highly inefficient AT system. As presented in Figure 6.11 operational inefficiencies contribute to AT product delays, inadequate AT supply, the provision of inappropriate AT (at least temporarily) and lack of sustained use.

Procurement blockages occur in the processes between ordering and receiving AT, both resulting from an overly complex procurement process, lack of capacity in personnel and inadequate information systems. A few public officials can cause severe delays in the procurement process and service providers often bear the burden of correcting these delays. Within medical aid companies, in-house administrative policies of were described as the 'main stumbling block' to increasing access to appropriate AT. Daily operations are hindered by the lack of information systems to manage and track AT client and product information.

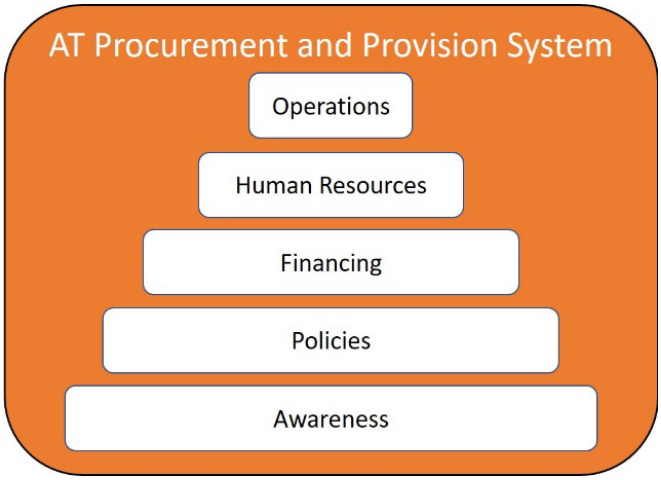
Figure 6.11 Operations building block: Outcomes and contributing factors



6.7 BRIEF SUMMARY OF THE AT PROCUREMENT AND PROVISION SYSTEM

In this chapter the five building blocks of the procurement and provision system that facilitate the supply of and access to AT were examined. Separating each of the building blocks helps to organize the findings but does not convey the relationships between these building blocks. In Figure 6.12 the five building blocks are stacked to better reflect the importance of each building block in strengthening the overall AT system. This simple ordering is derived from common patterns within the causal maps (e.g., awareness is identified as a root cause of other constraints).

Figure 6.12 Ordering of building blocks



Awareness (6.2) is placed as the foundational block within the procurement and provision system, meaning that all other four building blocks depend on the level of AT awareness. Policies are the next most critical block and positioned below AT financing as the main driver of funding for products and services. High level policies can act as levers to increase AT financing at global and national levels, whereas policy implementation tools (e.g., government tenders, medical aid coverage) shape how AT financing is channelled (i.e., products, services and suppliers). Finally, human resources and then operations are positioned above financing to depict reliance of on all building blocks below.

Given this arrangement, addressing gaps in AT awareness are essential to strengthening other building blocks. As depicted in Figure 6.3 the central gap is *what is possible*, specifically awareness about the broad range of AT possible and potential end users who can benefit. The low prioritization of AT is also attributed to multiple awareness gaps (Figure 6.3) and was identified as a contributing factor to weaknesses within three other building blocks (i.e., policies, financing, human resources).

When taking a closer look at the factors identified within each of the AT system building blocks, a prominent theme is the high level of fragmentation. Fragmentation is most noticeable across policies and funding mechanisms that contribute to a complex and inefficient procurement and

provision system. The complexity of designing comprehensive and integrated AT policies and funding mechanisms that address a broad range of AT products, services and sectors cannot be underestimated. The heterogeneity of AT products combined with the fragmented system make this a monumental task.

Most AT policies currently exist in the abstract due to fragmentation among AT policies at global and national levels, lack of technical guidance and inadequate implementation structures. Underpinning all the policy making and implementation challenges is the lack of resources devoted to policy research, design and implementation work.

Fortunately, much of this policy work and subsequent funding structures can be shared across the Southern African region and even adapted from existing policies within countries outside of the region. Comprehensive global AT policy instruments such as the WHA71.8 and future technical guidelines and sharing mechanisms developed by GATE can facilitate this policy development and harmonization process. To ensure implementation there is also a need for stable implementation bodies within Southern African countries. Currently there is a common understanding that policies are critical to increasing AT access, but few concrete examples were conveyed by participants about the types entities or mechanisms that should be responsible for implementation and enforcement.

This examination of the five building blocks also sheds light on the overall lack of understanding about current capacity of the AT system within Southern African countries. Even AT professionals who have worked in the field for over two decades were not able to convey baseline information about existing AT provision (quantity and reach of products and services) or coverage levels (AT types, amounts) by different funding streams. Without knowledge of the current capacity, it is challenging to determine the gaps across all building blocks, develop strategies to increase funding and monitor progress.

In the next and final chapter, a further synthesis of the complexities within the AT system are provided along with recommendations of how to elevate the priority level of AT and create a more integrated AT sector.

CHAPTER 7 DISCUSSION

7.1 INTRODUCTION

In this final chapter the key findings will be synthesized and interpreted to inform strategic recommendations for increasing access to AT in Southern Africa. Given the paucity of AT literature that addresses the AT sector within Southern Africa, this discussion will also draw evidence from the parallel fields of access to medicines and medical devices.

A brief summary of findings will be followed by descriptions of high level thematic patterns within the AT sector and a conceptual model of key constraints that result in unmet AT needs. Recommendations include seven strategic levers that have potential to make major shifts in the transnational AT sector. I have identified these levers in relation to primary constraints identified. Finally, limitations of this doctoral study are summarized followed by conclusions.

7.2 SUMMARY OF FINDINGS

Research findings presented in the scoping review (Chapter 3) and secondary analysis of survey data (Chapter 4) were used to refine the research aims and methods of the qualitative sub-study and provided additional evidence to understanding AT access. These two sub-studies also validated select findings reported in (Chapters 5 and 6) including:

- Lack of common conceptualization of AT, specifically definition, terminology and typology, was a finding of the scoping review.
- High level of fragmentation in AT sector (e.g., AT type) was reflected in existing research included in the scoping review.
- Unmet AT needs were found across all types of AT with greater unmet needs within the country with a weaker economy and less government AT provision in the secondary analysis.
- Prioritization of mobility AT over non-mobility AT across all building blocks aligned with findings of the secondary analysis.

As described in Chapter 2 Methods, the process and evidence of the scoping review shaped the conceptual boundaries of the study topic, AT access, and encouraged a more exploratory and flexible research approach. The secondary analysis pointed to the dominance of mobility devices within the sector, a theme that was examined further in the qualitative sub-study.

The regional qualitative sub-study relied on multiple data sources to understand the phenomenon of AT access. In addressing both primary research questions below across the three sector components, I generated a series of causal maps.

1) *What are the facilitator and barriers to AT access in Southern Africa?*
2) *How do identified factors interact with each other and the broader context to increase AT access in Southern Africa.*

Table 7.1 below provides the key characteristics (outcomes) of the three components the comprise the AT sector, with references to causal maps (Figures) that were included in synopses after each section within Chapters 5 and 6. All these figures are also presented in Appendix E.

Table 7.1 Key outcomes by AT sector component

	AT sector components		**Key outcomes**
CHAPTER 5	End users (Figure 5.3)		Lack of access Long wait time Lack of sustained use Receipt of inappropriate AT
	Product Supply (Figure 5.4)		Inadequate AT supply Provision of inappropriate AT
CHAPTER 6	AT Procurement and Provision System	Awareness (Figure 6.3)	Low prioritization of AT Informational barriers to procuring and providing AT
		Financing (Figure 6.5)	Inadequate AT financing Fragmented AT financing Inconsistent AT funding
		Human resources (Figure 6.7)	Shortage of direct service providers Poor quality AT services Provision of inappropriate AT
		Policies (Figure 6.9)	Inadequate AT products and provision policies Lack of AT policy alignment Lack of AT policy implementation
		Operations (Figure 6.11)	AT product delays Inadequate AT supply Provision of inappropriate AT Lack of sustained use

In an effort to begin bringing all these identified outcomes and relationships into one holistic model of the AT sector, I began with arranging the outcomes into a commonly cited health systems operational framework (WHO 2009). Outcomes identified are grouped and organized into sector inputs, outputs and end user experiences in Table 7.2 below. Sector inputs lead to outputs (e.g., lack of available AT) that are experienced by end users. Inputs operate behind the scenes to increase the supply of and access to appropriate AT. Outputs interface directly with end users and thus shape

their experience (i.e., lack of access, long wait times, lack of sustained use and receiving inappropriate AT).

Table 7.2 AT sector inputs, outputs and end user experiences

Sector inputs	Sector outputs	End user experiences
Inadequate AT financing (insufficient, fragmented and inconsistent AT funding) Weak policy environment (inadequate AT products and provision policies, lack of AT policy alignment, lack of implementation)	Inadequate supply of appropriate AT (product delays, provision of inappropriate AT) Inadequate services (shortage of services, poor quality of services, lack of information)	Lack of access Long wait time Lack of sustained use Receipt of inappropriate AT

This simple operational framework of the AT sector shows the relationships between surface level outcomes identified within the causal maps. Before presenting a more comprehensive model, it is necessary to describe the pervasive high level patterns within the AT sector.

7.3 HIGH LEVEL THEMATIC PATTERNS

When interpreting findings across all three components (end users, product supply and AT system building blocks) of the AT sector in Southern Africa, two high level interrelated patterns emerge. The first is the **low prioritization of AT** within all sectors (public, for-profit, non-profit) and settings (e.g., health, education). This pattern is a root cause of sector wide deficits, as shown across most causal maps. The second is the **high degree of fragmentation,** is also captured in many of the causal maps and portrays the complex operational nature of the sector. Fragmentation is caused by design or lack of design of the procurement and provision system, and by inherent complexities of AT products and associated services. Both these thematic patterns create an underfunded and inefficient sector where limited resources invested often do not translate into increased supply, access or sustained use of appropriate AT.

Pattern 1: Low prioritization of AT

The low prioritization of AT is a key theme that surfaces throughout the findings within all three components. The low priority of AT results in minimal resources invested in the sector, specifically:

- Insufficient AT financing for AT products and services: Financing is insufficient across multiple funding sources for AT (i.e., government, medical aid and non-profits) for all type of products and most end users do not have resources to purchase AT on the open market. Funding is also

lacking for AT services, specifically posts for direct service providers and adequate coverage of services (i.e., design of services, geographic reach)

- Lack of investments in local AT business development: There is lack of funding to start-up or scale-up local AT businesses (i.e., manufacturers), or other incentives such as tax breaks or assistance in securing government tenders.
- Lack of investments in strengthening the AT system: Minimal resources have been devoted to researching, designing and implementing approaches to address the constraints within the AT procurement and provision system. This has resulted in small-scale strategies, implemented by a few individuals or organizations, and often sustainable (e.g., raising awareness).

This phenomenon, the low prioritization of AT, results primarily from lack of awareness. Figure 6.3 displays the specific types of awareness gaps, namely *what is possible, extent of AT need and value of AT* that contribute to the low prioritization of AT. The central gap in this figure is *what is possible* in terms of the range of AT and potential populations that may benefit. Without this fundamental understanding of *what is possible* the scope and scale of AT will continue to be underrepresented and thus deprioritized.

The low prioritization of AT is also reflected and caused by the budgeting structures and processes within MOH. Budget allocations for AT are made within low levels of the system (e.g., facility level) contingent on few officials with limited knowledge, instead of allocated within budgets higher up the organizational structure and informed by evidence.

While AT as a sector is a low priority in relation to other health and development topics, there is also a ranking within AT. Mobility devices have received the most attention and resources globally and domestically (WHO 2008, WHO 2011, Visagie, Eide et al. 2017). This focus on mobility is reasonable given the high prevalence of mobility-related disabilities. Placement of these product types within government health systems and non-profit health-related programming also helps explain the emphasis on the health system. Yet this historical momentum appears to have become misaligned with AT needs (see Chapter 4); and may contribute to lack of awareness about the broad range of AT possible, and funding coverage limitations in procuring and providing non-mobility products on across most funding sources (government: MOH, MOE, MOSS, medical aid, non-profits).

Pattern 2: High level of fragmentation

The AT sector in Southern Africa has evolved in a piecemeal and disorganized fashion with few mechanisms to coordinate or synchronize the procurement and provision system across government, non-profits and for-profits actors; or countries within the region. Fragmentation is at

least partially attributed to the first pattern, low prioritization of AT, as limited resources have been invested to proactively understand and design a more integrated AT system.

The primary lines of fragmentation are along AT types, professional disciplines, funding mechanisms and policy structures.

- AT types: Research and practice often focuses on one type of AT (i.e., wheelchairs) or product category (i.e., mobility devices) but rarely encompasses a broad range of AT.
- Professional disciplines: A diverse range of AT related professionals are required to facilitate appropriate AT access and many of these professions operate in separate silos. Mechanisms that shape policy and practice (e.g., professional associations) which includes the provision of AT are often not coordinated across AT disciplines. Curriculum for rehabilitation professionals was also found to be inadequate in exposing future direct service providers to the broad range of AT.
- AT funding mechanisms: The multitude of government, medical aid and non-profit funding sources lack alignment in AT coverage (types, suppliers, costs), and regulations to ensure quality and sustained use. Non-profit funding sources were identified as the most fragmented due to changing external funding agendas that often target a specific type of AT or narrow populations.
- AT policy structures: There are numerous national policy instruments (e.g., MOH tenders) and regulatory structures (e.g., medical aid council) that lack alignment in content or coordination in implementation. In South Africa, the national standards body (i.e., SABS) also regulates select AT products. No one similar national regulatory examples for AT were found across the region. AT-specific policy tools at the global level have primarily focused on mobility and the health sector though this is changing with the recent passage of WHA71.8 and recognition of the multisectoral nature of AT.

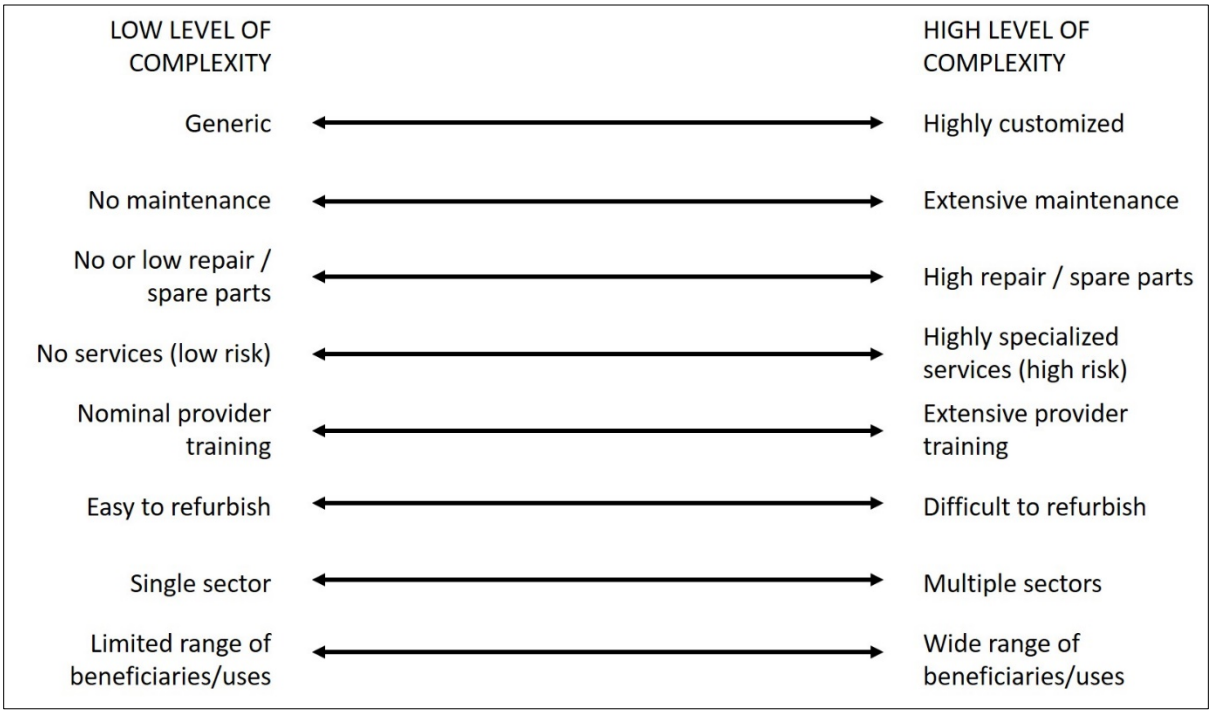
The high level of fragmentation is also apparent in the following sector characteristics:

- Multitude of uncoordinated actors: The sheer quantity of actors across the supply chain from manufacturers (global and local), intermediaries to direct service providers who act with minimal coordination also contributes to fragmentation. Lack of coordination was also identified within AT provision at the community level (Seymour 2019).
- Lack of system-level AT research: The existing evidence base on AT from Southern Africa is fragmented by AT type, setting and small parts of building blocks (e.g., clinical practice).

- Lack of holistic system-level AT programming: Procurement, provision and other programming focuses on one building block within the AT system such as training direct service providers in appropriate provision or increasing awareness.
- Lack of design for the full product lifespan: Numerous examples were provided of AT products that lacked post-sale services (training, repair, replacement). The lack of spare parts included in government tenders and/or repair services located within proximity to end users are major contributors to lack of sustained use.

As described in the bullet points above, fragmentation results from both the heterogeneous nature of AT products, and weaknesses within the broader AT system designed to facilitate AT supply and access. Designing the AT procurement and provision system must take in account the complexities of different product types. The complexity continuum presented below (Figure 7.1) presents the many ways AT products are heterogenous.

Figure 7.1 Complexity continuum of AT products



Source: R.Matter

It is likely that organizing AT into product segments can simplify the design of the AT system. This exercise of product segmentation was not within the scope of this analysis, but some speculations are provided to be explored further. Possible product segments could include:

- Devices that are high-risk and will only be provided by rehabilitation professionals within for-profit, governmental or non-profit health care entities.

- Devices that are multisectoral, medium-risk and can be provided by a wide range of trained providers (e.g., educators, CHW).
- Devices that can be provided by direct and full-service suppliers to end users. Given the expertise and post-sale services often available from direct and full-service suppliers, it is likely that a segment would be most effectively and efficiently provided to end users by these suppliers. While multiple funding sources can pay for the products (e.g., MOH, RAF, or medical aid) the selection, provision and ongoing services (repair, spare parts) would be the responsibility of the direct and full-service supplier. This approach may circumvent operational inefficiencies within the often highly bureaucratic provision systems found within the public sector.

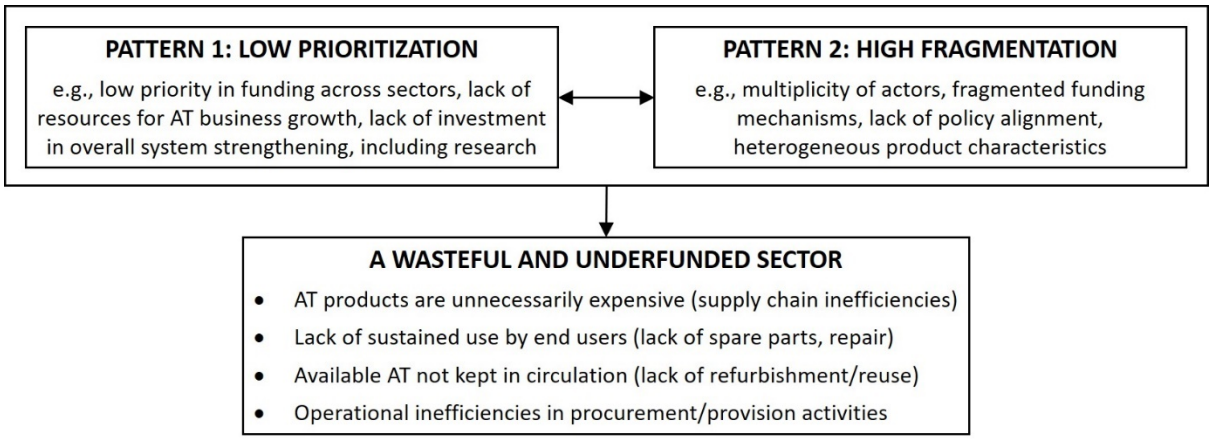
The high level of complexity across AT products presented in above in Figure 7.1 suggests that increasing AT access is new territory of research and practice. Therefore, solutions must draw from other industries that are multisectoral with a heterogenous product profile.

Consequences of low prioritization and high fragmentation

The two patterns described above are mutually reinforcing. Fragmentation reduces the priority level of AT as AT is not understood or treated as a unified sector with a large population of unmet needs. Low prioritization of AT results in low investment in understanding and designing a more integrated sector. The limited resources invested have resulted in a patchwork of solutions that are implemented by a few individuals or organizations, inconsistently applied and often unsustainable. These patterns are not unique to AT, having been identified in the broader public health challenges in sub-Saharan Africa (Agyepong, Sewankambo et al.). Yet, I expect they are more pronounced regarding AT than found in other sectors, given the minimal investment.

The combination of these two patterns leads to a wasteful sector, meaning that the few resources invested are not used effectively or efficiently to increase access to appropriate AT. Figure 7.2 displays these two high levels and consequences.

Figure 7.2 High level patterns of the AT sector and consequences

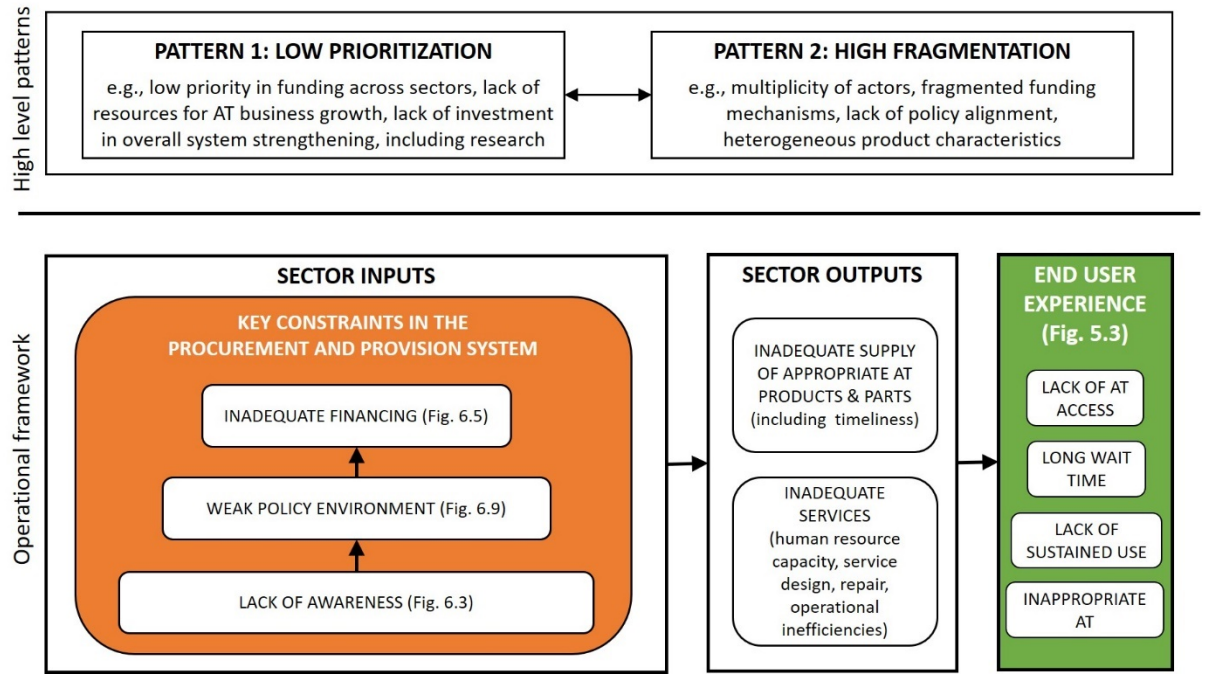


Source: R. Matter

7.4 MAJOR AT SECTOR CONSTRAINTS

The original aim was to develop a theoretical model that explains how multiple factors interact with to increase AT access in Southern Africa. Given the absence of evidence on *what works to increase AT access*, a conceptual of model of major AT constraints was developed as a preliminary hypothesis to explain the phenomenon of AT access. This model is not exhaustive, as numerous specific factors detailed across the causal maps are excluded.

Figure 7.3 High level patterns and key constraints within the AT sector

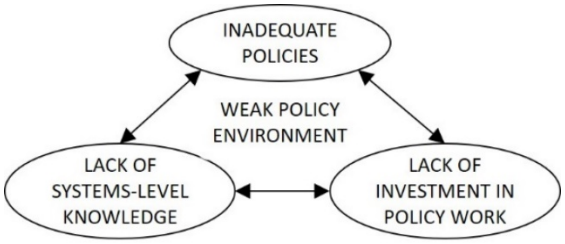


Source: R. Matter

Figure 7.3 above builds upon the operational framework (Table 7.2), incorporates the two high level patterns and the ordering of AT system building blocks presented in Figure 6.12. At the top, are the high level patterns. At the bottom, the operational framework points to the ordering of building blocks (sector inputs) from the most foundational, lack of awareness, to subsequent weaknesses in other building blocks within the AT system.

A weak policy environment encompasses the underlying factors and outcomes identified previously in Figure 6.9 (e.g., lack of harmonizing mechanisms that result lack of policy alignment), as well as the lack of knowledge about the AT system (e.g., current needs and capacities) and inadequate investment in policy design and implementation. These three deficits (depicted below in Figure 7.4) are mutually reinforcing and hinder strengthening of subsequent building blocks (i.e., financing, human resources, operations).

Figure 7.4 Weak policy environment



Source: R. Matter

Inadequate financing includes both lack of funding of products and services, and inadequate investment in AT business development. These constraints lead to unmet end user needs.

7.5 RECOMMENDATIONS FOR INCREASING AT ACCESS IN SOUTHERN AFRICA

The following recommendations aim to address the overarching question that directed this doctoral research. This question has been reframed as What **could** work to increase access to assistive technology in Southern Africa? as none of the levers have been tested in the AT sector.

Recommendations are derived from the findings and syntheses of all three sub-studies (i.e., scoping review, secondary analysis and qualitative) and have been narrowed down to seven strategic levers that address the high level patterns and major constraints identified in Figure 7.3. Most recommendations apply to the Southern African AT situation broadly, with a few differentiated for higher (South Africa, Namibia, Botswana) or lower income countries in the region.

The end goal of increasing AT access is more than increasing the percentage of end users who access AT throughout Southern Africa. End user indicators of greater access also include the timeliness of access appropriateness of products and services and level of sustained use (Figure 7.3).

Overview of strategic levers

As AT attracts more attention and funding globally and nationally, effectively channelling these resources to strengthen the AT sector in Southern Africa faces substantial challenges and potential missteps. For Southern Africa, it would be futile to re-engineer a more integrated AT system from scratch as there are already too many actors, policies, financing structures, and procurement and provision processes in place. While arguably the best and most efficient models are centralized (Sund 2019), this model has low feasibility for success within Southern Africa given the complex AT sector landscape and inadequate government budgets. What is possible is to 1) elevate the priority level of AT to increase level of resources invested; 2) stitch together and standardize fragmented parts where feasible; and 3) implement strategies to reduce waste within the sector.

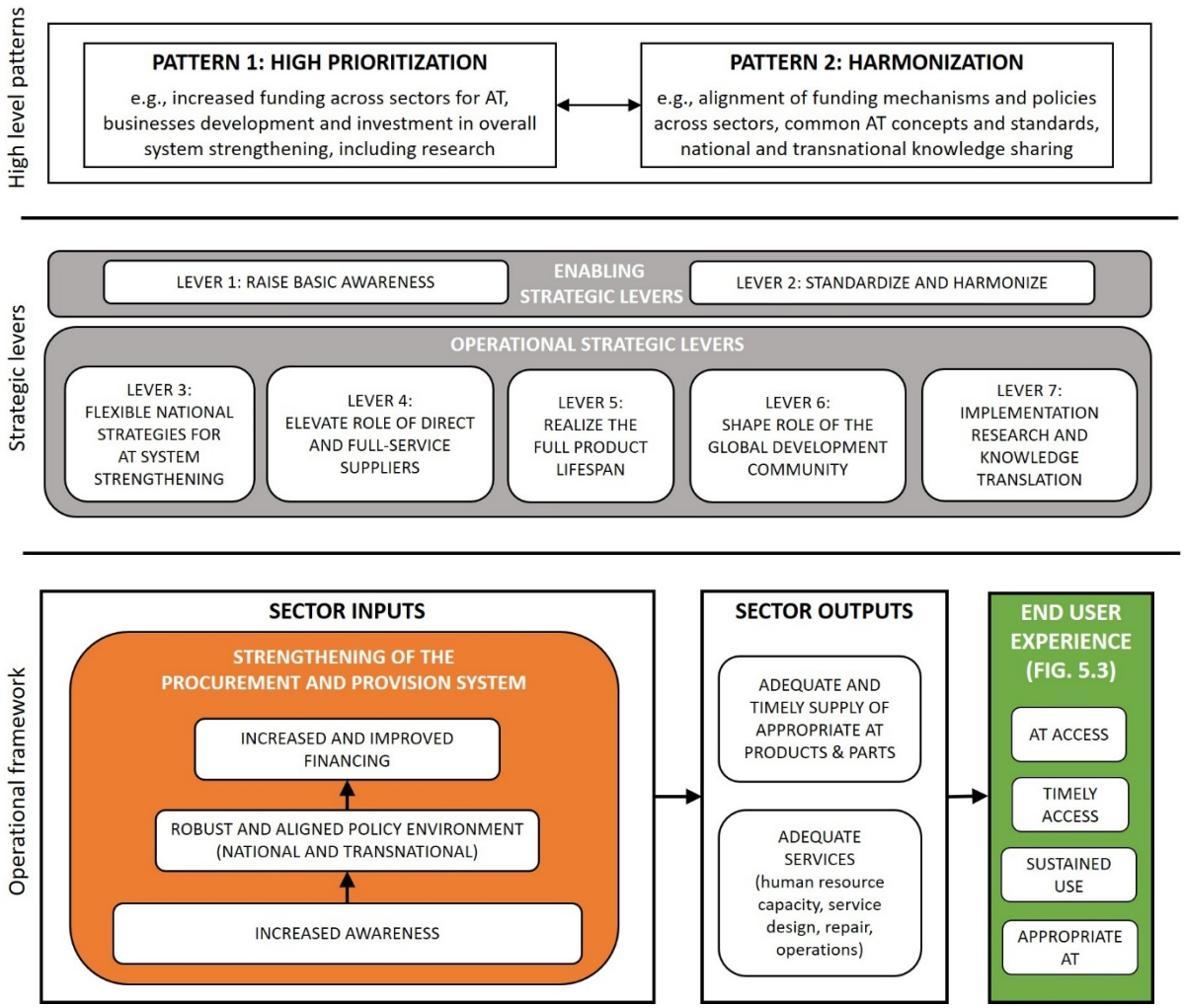
The seven strategic levers described below are informed by evidence generated through this study. I have good reason to think that addressing these bottlenecks is critical to increasing AT access. Yet I am uncertain about how feasible these levers are as noted in my reflections.

In Figure 7.5. below, the first two levers are labelled as 'enabling' while the remaining five are labelled as 'operational'. This distinction is made because the first two most directly address the high level patterns identified (i.e., low prioritization and high fragmentation), thus creating an enabling environment for the AT sector across Southern Africa. The 'operational' strategic levers focus on addressing key system-wide constraints to strengthen AT provision and procurement. These five depend on an enabling environment, the first two levers.

Using the term 'strengthening' came from the health systems literature. Yet, I did not locate a holistic model of health system strengthening that reflected the key findings and subsequent key levers derived from this study. There is a lot of discussion about needing integrated approaches to addressing the complexities of weak health systems in LMICS, though health system strengthening interventions tend to focus on a few building blocks and evaluating effectiveness of interventions is challenging (Sherr, Fernandes et al. , Adam, Hsu et al. 2012).

The model below (7.5) is grounded in the research findings and aims to be holistic and address system-level constraints. Many strategic levers are consistent with those outlined in the medical device and medicines literature (e.g., need to standardize and harmonize the sector), as noted in the narrative below. Other levers may be unique to AT and the existing AT structures and actors specific to Southern Africa. This model is a starting point and will hopefully garner critique and improvements as more AT sector evidence and insights becomes available.

Figure 7.5 Strategic levers to increase AT access within Southern Africa



Source: R. Matter

Strategic lever 1: Raise basic awareness

Data suggests that the lack of basic AT awareness is the most fundamental bottleneck to increasing the priority level of AT. Specifically, there needs to be broad based awareness raising about the range of AT products and audiences that may benefit from these products (i.e., *what is possible*, see Figure 6.3).

The other types of awareness identified in Figure 6.3 include *extent of AT need, value of AT, how to obtain AT, why access AT* and *what is appropriate AT.* Addressing all these awareness gaps depend first on addressing the fundamental awareness of *what is possible*. If this foundational awareness was absent in the parallel field of medicines, pockets of different product categories (antiretrovirals vs. anaesthetics) would be understood by various actors, including policy makers, but medicines would not be perceived, invested in or designed to operate as a sector.

Current efforts to elevate the profile of AT globally, nationally and even at facility levels are piecemeal and unsustainable. Awareness raising activities are often fragmented by AT type or professional discipline. Establishing a uniform definition, taxonomy of product categories and potential beneficiaries for the AT industry would be helpful in awareness raising. Ensuring beneficiaries that have been less represented in AT research and practice such as people with intellectual disabilities (Boot, Owuor et al. 2018) are included is essential. Building consistent and comprehensive awareness of AT in Southern Africa will elevate the priority level, thus increasing financing or products and services, and resources devoted to understanding and strengthening the sector.

While this basic awareness is needed for all actors and sectors, the first audience to prioritize is direct service providers. Direct service providers within the health, education or other fields require broader knowledge about AT to address the needs of the populations they serve. In addition, they likely play a role in system-change, specifically raising AT awareness and advocating for increased and improved financing and policies within their respective systems.

For countries with greater government engagement in AT procurement and provision (i.e., South Africa, Namibia, Botswana), key officials directly involved in the AT budgeting and procurement process require basic AT knowledge. As found in the case of South Africa, AT allocations and even specific products selected are often decided for a few officials with limited knowledge of AT.

I would further argue that while addressing the other awareness gaps such as demonstrating the *value of AT* are necessary to increase the priority level, as identified by WHO GATE (WHO 2017a), this is secondary to this basic awareness needed in Southern Africa. Conducting research that determines the value of AT in terms of economic cost benefits or participant outcomes, will be less impactful among policy makers and practitioners who do not have a baseline understanding of *what is possible* (i.e., product range, potential beneficiaries).

The types of information needed to address many awareness gaps (*what is possible, value of AT, why access AT* and *what is appropriate AT*) are likely to be consistent across the Southern African region. Thus, there is a need to create centralized and share information resources to address these gaps. The WHO GATE initiative aims to create a global resources which can help centralize and standardize some of this needed information (WHO 2015). Content modifications will be needed to match the Southern African context.

Strategic lever 2: Standardize and harmonize

Below are standardizing and harmonizing strategies to support AT operating as a sector across Southern Africa instead of as a constellation of uncoordinated parts. This lever directly addresses the fragmentation pattern.

Conceptual uniformity

Establishing uniform AT terminology and taxonomy is one aim of the WHO Global Report on Assistive Technology (Borg 2019). As recommended in sub-study 1, a uniform definition of AT would also advance the field of AT research by allowing for comparability and meta-synthesis. Synchronizing the AT taxonomy with ISO classifications will build upon industry standards that are already used worldwide. Mapping the APL to select ISO product types will place the 50 priority products within the global classification scheme.

While AT has often been relegated to only the health sector, the recently passed WHA71.8 links AT access to the achieving all 17 SDGs which goes beyond health. Developing consistent language that frames AT within all relevant sectors and potential uses (e.g., health, education, employment, civic life) will assist in broadening the understanding of AT. This language should apply a rights-based orientation towards increasing AT access to reduce the tendency to develop interventions that address individuals' health or medical need and increase likelihood that AT provision becomes fundamental in creating a more equitable society. As outlined in the policy section (6.5), the CRPD and national rights-based legislation that addressed multiple domains (e.g., employment) speak to the right-based approach but lack consistent language.

Finally, conceptual frameworks for understanding the AT sector will help unify research and practice. The typology of research focus area presented in the scoping review (Chapter 3), and conceptual models of the AT sector within this thesis can be further developed and tested.

Product segmentation

While this idea is preliminary, there are likely to be segments of products that require different AT system designs. This is the middle ground between trying to fit a broad range of products within 'one model' (i.e., health systems/rehabilitation model) and needing a vast array of models to accommodate different product types (see Figure 7.1 Complexity continuum). One way to segment products is by risk category. A risk-based classification system for AT products differentiates level of regulations needed to ensure quality and safety. Low-risk off-the-shelf products can be sold at pharmacies or other for-profit retailers with no or minimal regulatory requirements while high-risk products that need clinical/technical services will be subject to greater scrutiny. Risk-based

classifications for AT are likely to have already been developed by global and/or national professional associations, so can be shared and adapted as needed for Southern Africa.

Transnational harmonizing mechanisms

Networking and knowledge sharing are needed to develop more consistent policies and practices and increase coordination among the multitude of AT actors across Southern Africa. Coordination between actors within all three sectors (government, non-profit and for-profit) is needed to strengthen the building blocks and reduce inefficiencies at national and transnational levels. Given the time and resource intensive nature of developing standards to facilitate the procurement and provision of appropriate AT, sharing standards will reduce redundancies in these efforts. South Africa has done the most work in the region in establishing AT policies and practices and thus may be the most logical country to develop and manage a transnational knowledge sharing platform. Specific types of tools to share may include:

- Tendering specifications (product types, quality and service standards, pricing). For example, South Africa (see Box 6.1) can share details of AT advisory committee model.
- List of preferred suppliers (i.e., direct and full-service suppliers).
- Regulations of minimum AT coverage for all major funders (e.g., medical aid, MVA).
- Tariff exemption policies and best vehicles for implementation.
- Scope of practice, best practices and training curriculum for AT professionals involved in AT provision.

In addition, two transnational bodies were identified through this study that are well-positioning to harmonize some AT policies and practices across multiple countries in Southern Africa. The mission of the Southern African Development Community (SADC) is to achieve regulation integration and eradicate poverty. The Southern African Customs Union (SACU) is a regulatory body that covers Botswana, Lesotho, Namibia, South Africa and Swaziland, and aims to harmonize policies to facilitate trade and economic growth in the region. Key areas to harmonize within the AT sector include:

- AT trade policy: Findings suggest that some Southern African countries already have tariff exemptions for select types of AT products which SADC can broaden.
- Exemptions in economic empowerment policies: If direct and full-service suppliers are not available within the country, AT should be procured directly from these expert suppliers In South Africa without the requirement of channelling the product through a locally owned redundant intermediary.

- Investment in domestic AT sector: Provide financing and incentives to develop and scale-up local AT businesses (manufacturers, service providers, reuse programs) to serve the Southern African market.

Rely on work of regulatory authorities outside of Southern Africa

One strategy utilized to reduce the duplication of efforts and increase harmonization for medical device regulations is to piggyback on regulatory authorities outside of Southern Africa. This can expedite the registration and licensing of suppliers, providers and products with medical devices. For example, medical devices that have already gone through regulatory procedures of the Australian Therapeutic Good Administration (Saidi and Douglas 2018) are then automatically approved for retail in Southern African countries. This approach would be particularly helpful in countries with weaker regulatory infrastructure. As evident by the following statement on the SAHPRA website, this is already happening for medical devices approved within several countries.

> *In order not to prevent duplication of regulatory effort in South Africa, SAHPRA will implement reliance pathways in the registration of medical devices based on recognised verification of registration of medical devices in some other jurisdictions including: Australia, United States, European Union, Brazil, Canada, Japan and/or pre-qualification of IVDs by the World Health Organization (South African Health Products Regulatory Authority 2019b).*

Given that regulatory delays have been identified as a major bottleneck to increasing supply and innovation of medicines and medical devices within Southern Africa, the AT sector can avoid the misstep of creating new regulatory systems (Saidi and Douglas 2018). Regional harmonization of regulations for essential medicines is also recommended globally (Wirtz, Hogerzeil et al. 2017). Furthermore, AT suppliers with products that are manufactured locally or overseas would welcome this approach as it would assist in reaching transnational and global markets.

Synchronizing regulations at the national level

Synchronizing regulations across funding mechanisms at the national level can reduce redundancy and harmonize standards. For example, in South Africa medical aid coverage decisions may defer public sector regulations. As stated on the Council of Medical Schemes website:

> *Should there be a disagreement about the treatment of a specific case, the standards (also called practice and protocols) in force in the public sector will be applied (Council for Medical Schemes 2019a).*

Strategic lever 3: Flexible national strategies for AT system strengthening

Across Southern Africa there are diverse economic and demographic contexts, levels of capacity within the AT sector and, arguably, AT needs among end users. Two key elements of designing

flexible strategies to strengthen AT procurement and provision systems within each county are 1) building from the existing capacity with the AT sector, and 2) identifying and funding suitable national implementation structures (e.g., regulatory, coordinating).

Build upon existing AT sector capacity

The is a vacuum of information on both the needs and current capacity of the AT sector in Southern African countries. Even in South Africa, participants were only able to provide general impressions of unmet needs, existing coverage of AT products and services and capacity of system-level building blocks (i.e., policies, financing).

Two recently published WHO reports aimed to capture the capacity of the AT sector at regional (Africa) and county levels (Tajikistan).

- Assistive technology in the African region: results of an online rapid assistive technology capacity survey: A recent report on the AT capacity in Africa included data from five Southern Africa countries (Madagascar, Malawi, South Africa, Tanzania and Zimbabwe) and identified several weaknesses within the AT sector (e.g., lack of AT regulations, inadequate AT workforce, dependency on NGOs) that are consistent with findings in this doctoral study (WHO Regional Office for Africa 2019). The report focused on the health system and rehabilitation professionals though some products were not health specific (e.g., simplified mobile phones, Braille equipment). Of the 65 stakeholders who contributed to the report, the highest number from South Africa and over half were health care professionals. This heavy reliance on data from the country with the strongest AT sector in the Southern Africa region (South Africa) may offer an optimistic presentation of the region but is nevertheless a starting place to assess existing capacity.
- Assistive Technology in Tajikistan: Situational Analysis: Survey research conducted in Tajikistan is being used to develop a national AT strategy (WHO 2019a). Consistent with the findings of this study, the assessment in Tajikistan showed that available AT was primarily limited to mobility devices. The national strategy designed aims to centralize funding through the Ministry of Health and Social Protection, and AT provision and provision through the National Orthopaedic Centre, that will become the National Assistive Technology Centre.

Both reports include an assessment of the AT system building blocks covered in this study, yet the level of data does not describe how the current AT sector is operating, or specific strengths within each country to build upon. This detailed information is needed to design concrete and customized strategies and may be better captured through qualitative approaches.

Within each country in Southern Africa, substantial differences are anticipated to be found in the level of fragmentation and resources; and subsequent provision (e.g. composition of the AT workforce). For example, when considering human resources, DPO or CHWs networks may play an active role in AT provision and this strength can be leveraged in the design and implementation of AT system strengthening strategies. In a higher resourced county in the region (i.e., Namibia) where there are already a cohort of AT-related professionals (i.e., rehabilitation professionals, AT specialists, social workers), the focus may be on extending the roles of these professionals to cover a broader range of AT, as recommended in a recent publications (Ennion and Johannesson 2017, Smith, Gowran et al. 2018).

For each building blocks, priority setting at the national level by key stakeholders should be built into the assessment process of current AT sector capacity and serve as the driver of donor funding. This is one lesson that can be learned from medicines sector as external donor versus nationally driven priorities were often found to pose a barrier to increasing access (Sridhar and Batniji 2008).

Identifying suitable national implementation structures

It takes considerable effort to develop global and national level AT policies, yet implementation of these policies often falls short. One key reason identified through this study is the lack of technical guidance to translate high level policy tools into action. Another missing link is 'who' or 'what' is responsible and accountable for policy implementation at the national level. As the global community works to shape the process and content of National Assistive Technology Policies (MacLachlan, Banes et al. 2018), it is important to anticipate and design for national implementation challenges within a complex landscape.

The global discussion about national AT structures has historically focused on the health system, though this is changing with the recognition that AT operates within a broad range of sectors (Boot, Owuor et al. 2018, MacLachlan, Banes et al. 2018, Tangcharoensathien, Witthayapipopsakul et al. 2018). With this recognition there is a risk diffusing the responsibility of national implementation across many government ministries with no clear accountable centre. The narrower approach of only focusing on the health system (MOH) provides that accountable centre but will negate a wide range of products, sectors and providers (e.g., employers) and thus reduce access to end users. The ideal centre structure and role for that structure was not identified through this study though considerations and some potential models were identified:

- How to best leverage existing national policy structures? Government ministries/agencies, for-profits and non-profits across multiple sectors such as health, education, social welfare and employment are likely to have some AT regulations already in place, especially in

countries with more robust economies such as South Africa or Namibia. For example, South Africa has national employment policies on reasonable accommodation that include the provision of AT. Instead of developing a new policy body dedicated to AT that must address the complexity of regulating a range of product categories and align within multiple existing policies across diverse sectors, it may be more feasible and economical to leverage existing national structures that can also rely on regulatory authorities outside of Southern Africa as appropriate. Identifying and assessing the capacity of existing structures can be conducted by a national-level expert advisory group. Again, this process will be complex and thus costly given the high level of fragmentation within the AT sector. A few models for focused on AT regulatory activities that were identified through this study include:

  - Expanding role of national standards bodies to include AT: In South Africa, the national regulatory body SABS has developed a 'Disability and Accessibility' section that include a subsets of AT products. The scope of AT covered thus far includes, '*accessibility to ICT for persons with disabilities & elderly, escalators and passenger conveyors, assistive products for persons with disability, assistive mobility devices for persons with disability, universal access and universal design in the built environment' (South African Bureau of Standards 2019b)*.
  - Using health product regulatory bodies: Considering that many Southern African countries already have dedicated regulatory bodies for health products (medicines and/or medical devices), these bodies may be most suitable for incorporating health-related AT products but not non-health products such as an alternative input device for computers. Ideally, this same health focused regulatory body would apply to a range of AT funders that cover health-related at such as MOH, RAF, WCF and medical aid.

- How best to centralize the AT system? The approach to centralization of the AT system will depend on current capacity within each country. This Tajikistan model includes only two existing government structures to centralize the AT system, that have historical focused on mobility devices (WHO 2019a). This model of centralization is unlikely to work in Southern African countries with a highly fragmented AT landscape. As suggested early, product segments may be the level at which the AT system can be centralized, meaning that there are multiple policy and implementations centres within the AT procurement and provision system. Whichever national structure(s) are identified for each country to centralize the AT system, the aim should be to facilitate supply and access to appropriate AT and not create burdensome bureaucratic processes, which are already problematic.

- What role does each national implementation structure play in the AT system? It is important to note the breadth of regulations required to facilitate appropriate AT access, starting from policies for research and development of new AT products and services, procurement, appropriate provision and ensuring product lifespans are realized. One key regulatory component is registering suppliers and products to enter the Southern African market, to then be purchased by government, for-profit or non-profit buyers. As described under Lever 2, this important regulatory task performed by national standards bodies or separate entities devoted to health products can be harmonized across Southern African countries to reduce duplication and inconsistencies.
- What types of AT need to be regulated? As stated under Level 2, a risk-based classification system for AT that differentiates products that do and do not require provision regulations will also serve to simplifying the AT regulatory and implementation landscape. A growing subset of low-risk AT products can be purchased directly by end users.
- How much to focus on shaping the for-profit sector? The for-profit health sector is growing in many Southern Africa countries. Medical aid companies can play a large role in increasing AT access but few regulations are in place to regulate behaviour (minimal benefits that include AT provision). There is a need to strengthen regulations of medical aid companies and for-profit providers as to not undermine public health agendas (Doherty 2015, Mackintosh, Channon et al. 2016).

All of these considerations described above can help shape national assistive technology policies to ensure relevance and that strategies are actionable and implemented.

Strategic lever 4: Elevate role of direct and full-service suppliers

Elevating the role of direct and full-service suppliers can serve as a key harmonizing force within the AT sector and directly address several inefficiencies (i.e., supply chain inefficiencies, limited product lifespan, products not kept in circulation). Characteristics of direct and full-service suppliers are:

- Direct relationships with manufacturers or are manufacturers themselves
- Expertise in the AT industry
- Provide post-sale services (e.g., repair, training) to ensure appropriate and sustained use of products. This may include providing outreach services to reduce travel time for end users
- Invested in growing the national and transnational AT market

Four ways to elevate the role of direct and full-service providers are described below.

Purchase AT from direct and full-service suppliers

All major funders of AT for Southern Africa (see Table 6.4) should procure AT from direct and full-service suppliers in the region to reduce product costs, increase product quality and increase likelihood of timely post-sale services. Most of these suppliers are based in South Africa and some are also local manufacturers.

An underestimated value of these suppliers is that they are likely to have replacement products and spare parts in local stock and thus able to provide post-sale services (i.e., honour product warranties) to providers or end users in a timely manner. As shown in the Ferrule Story (Box 6.2), AT budgets are wasted when low-cost spare parts are not available locally.

In terms of feasibility, non-profit and for-profit buyers have greater flexibility to purchase from direct and full-service suppliers whereas government buyers may be subject to procurement policies or practices that can increase likelihood of purchasing from redundant intermediaries. As shown in this study and other research from Southern Africa, economic empowerment policies can add redundant intermediaries to the supply chain (Shumba and Moodley 2018). International NGOs that channel AT funders toward these local suppliers instead of bringing in donations that can undermine the local manufacturing can make a significant difference.

Gathering and maintaining a list of these direct and full-service AT suppliers that serve the Southern African market is needed to facilitate purchasing from all sectors. The AT-Info-Map project began the task of identifying and mapping self-identified suppliers and this work can be built upon to filter out those that do not meet the criteria of direct and full-service suppliers (Appendix D).

Engage direct and full-service suppliers in shaping national AT policies and tools

Direct and full-service suppliers should play a major role in shaping national AT policy and tools within the procurement and product systems (i.e., tender specifications). Their expertise in AT and understanding of the AT market in Southern Africa is invaluable to designing effective policies across all sectors (e.g., minimum benefits for medical aid, employer AT policies). Substantive engagement of these suppliers in policy development requires sustainable national policy structures, as discussed under Lever 3. One concrete example is to have technical AT experts from these suppliers review and approve AT businesses and products. The lack of relevant technical expertise has been identified as an obstacle to implementing medical device regulations in South Africa (Saidi and Douglas 2018).

The practice of engaging technical industry experts was modelled in the South Africa MOH process for developing AT tendering specifications and was cited as effective within well-resourced countries (Sund 2019). Given the highly technical and time-consuming nature of developing and continually refining procurement and product standards for a broad range of product categories, transnational

harmonizing structures can facilitate sharing of well-developed technical specifications to reduce the duplication of efforts among Southern African countries.

Expand role of direct and full-service suppliers in provision

Beyond serving as the point of purchase, these AT suppliers can provide services for some AT categories directly to end users/buyers, such as conducting training, and providing repair and replacement services. Outsourcing logistics (i.e., supply chain management) and product delivery has also been shown to increase timely access for vaccines (Songane 2018).

Learn from direct and full-service suppliers

Researchers aiming to understand market dynamics would benefit from tapping into industry knowledge of direct and full-service suppliers. These suppliers are likely to focus on the AT market broadly and not just government procurement from core ministries (i.e., MOH, MOE). Thus, they are well-informed about the range of products purchased, divergent standards, operational challenges and post-sale service needs among a wide range of buyers under government (e.g., RAF, WCF), medical aid, non-profits, private educational institutions, employers, etc. They also can assist in identifying strategies to expediate the uptake of new products, as the cumbersome process for registering new products was found to be a barrier for innovations to enter the regional market.

As stated in Section 5.3 of 'direct and full-service supplier' was a label I created to define AT manufacturers and or suppliers that characteristic bulleted above. These characteristics are not found in redundant intermediaries (aka briefcase suppliers, middlemen). However, there is a continuum between these two opposing roles. For lower risk products that require less training or ongoing maintenance, the 'full-service' aspect may be not as important. Regardless, direct purchasing will be more cost effective and the long-term investment in the AT industry means staying informed about new product innovations and best practices.

As these direct and full-service suppliers become the primary procurement channels across all sectors (government, for-profit, non-profit), the noise of the multitude of buyers and inefficient supply pathways will be reduced.

Strategic lever 5: Realize the full product lifespan

This lever focuses on reducing a source of waste within the current AT sector, the lack of repair and reuse services to keep product in good working condition for current and future end users. As described in Section 5.3 Product supply, products are made or imported into the Southern Africa region of varying levels of quality, appropriateness and local reparability. Even with government funding sources that have established regulations to restrict procurement to appropriate products,

there are a wide range of specific product designs, quality levels and brands procured. Furthermore, some procurement decision makers do not adhere to these regulations so low-quality and inappropriate products continue to enter the local market.

Most products of suboptimal quality, in disrepair, or no longer needed by the end user have potential for repair, refurbishment and/or reuse. As found within one province in South Africa, a reuse program was able to supply 60% of wheelchairs needed (Section 5.3 Product supply). Well-designed repair and reuse programs and ensuring spare parts are supplied can avoid many system level inefficiencies (e.g., delays in procuring and shipping new AT, redundant intermediaries in the supply chain), and provide local capacity building and entrepreneurial opportunities (MacLachlan, McVeigh et al. 2018).

This strategic measure could result in substantial cost savings. Considering the high cost of AT products (e.g. supply chain inefficiencies), extending the life of these products is a low hanging fruit. For products that are already procured through government tenders, this solution could be as simple as adding spare parts line items for each product type and ordering those parts when the products are purchased so they are readily available. As demonstrated in the Ferrule Story, Box 6.2., and another study of prosthetics in South Africa (Ennion and Johannesson 2017), spare parts costing as little as .25USD (binding clip, p.183) or $1.50USD (ferrule) prevent end users from sustaining use of AT and keeping these products, when reusable, in circulation.

Strategic lever 6: Shape role of the global development community

This lever speaks to how the global development community can shape the future of the AT sector within Southern Africa.

WHO GATE and other leaders within the global AT development community (international non-profits, other multilateral agencies, donors/funders) aim to increase uniformity and harmonization within the highly fragmented and complex sector globally and focus on regions with the highest levels of unmet AT needs like Southern Africa. As presented at GReAT in August 2019:

> *Confirmed that global partnerships have been successful and addressing fragmented and under resource sectors, such as that of through increased political prioritization and coordination, a high level of sustained resources, and they have successfully transformed market (Fineberg 2019).*

The recently passed WHA71.8, APL, national AT assessment surveys, pending Global Report on Assistive Technology, APL, and technical resources (e.g., Assistive Product Specifications for Procurement) can assist in achieving this aim. As found in Section 6.5, technical guidance for a range of AT policy instruments are a critical to achieving implementation at the national level. I further

argue that the technical guidance be accompanied by ongoing support in implementation to adapt global instruments to a range of national structures (Lever 3). The complexity of the AT sector within Southern African countries combined with lack of system-level evidence of 'what works' places a higher demand on global actors to bridge the gaps between global policy and national implementation.

Additional dos and don'ts regarding the role of the global development community include:

Working through global harmonizing bodies

Identifying and influencing global harmonizing bodies that shape AT policy and practice within parts of the Southern Africa sector can contribute to GATEs aims. For example, the International Social Security Association (ISSA) sets international guidelines for worker compensation funds (WCF). WCFs are common throughout Southern Africa. ISSA's Return to Work and Reintegration Guidelines includes the provision of AT (International Social Security Association 2016). Other examples are global professional associations that have established educational standards that can be adapted for Southern Africa (Cochrane 2019).

Selectively apply market shaping strategies

At the 2019 WHO GReAT event, multiple presenters cited that market shaping strategies should be modeled for stimulating growth in the AT sector since they have proven effective in increasing supply of other products (i.e., bed nets, ARVs) (ATscale Global Partnership for Assistive Technology 2019, Austin 2019, Fineberg 2019, Holloway 2019, Savage 2019). However, AT is much more complex (i.e., product heterogeneity, level of fragmentation is the procurement and provision landscape) and thus market shaping strategies may require substantial modifications and/or segmentation by product categories. For example, mass produced AT products that have little variation (sizes, features) such as a shower chair, government can negotiate discounts for bulk purchasing (pooling procurement) with larger suppliers/manufacturers, as has been found effective with ARVs (Modisenyane, Hendricks et al. 2017) and recommended within global market shaping initiatives (ATscale Global Partnership for Assistive Technology 2019).

The 'heterogenous nature of AT' is mentioned in a recently published working paper developed by AT2030 (Albala, Holloway et al. 2019) show that this complexity is appreciated. Furthermore, systems-thinking combined with market shaping approaches have been proposed to address nuances and contradictory interests among actors in AT industry (MacLachlan, McVeigh et al. 2018). Given the unique aspects of the AT sector, targeted market shaping strategies require testing to determine effectiveness before assuming they will work.

Reduce fragmentation in AT programming

Targeting a few types of AT or/and subpopulations has been shown to exacerbate an already highly fragmented sector. While it is not feasible to address all AT and beneficiaries, large international NGOs and global agencies have the capacity to broaden the scope of AT to much larger subsets (e.g., sensory devices) or even sectors (AT within educational settings). More holistic AT programming should also be sustained long-term.

Learn from experiences of increasing access to medicines and medical devices

After billions have been invested over four decades to increase access to essential medicines in Southern Africa, this sector remains dependent on donor funding and continues to experience supply and access challenges (Cameron, Ewen et al. 2009, Mahmic-Kaknjo, Jelicic-Kadic et al. 2018, Songane 2018, Wouters, Sandberg et al. 2019), particularly with medicines for chronic conditions (Vialle-Valentin, Serumaga et al. 2015). A great deal of research and action have been applied to understand and increase access, address supply problems (e.g., tracking stock outs), consolidate procurement to reduce prices, establishing regulations (e.g., price mark-ups), and increase resource commitments from national governments (Cameron, Ewen et al. 2009, Magadzire, Marchal et al. 2015, Yadav 2015, Rennie, Kibuule et al. 2019). Given that medicines are much simpler than AT in many respects and have different considerations (e.g., storage, shelf-life), models may not apply but there are best practices that can apply, and missteps that can be learned from and avoided. For example, in a country that is in the process of developing AT provision through the ministry of health, a district hospital may be given the autonomy to order AT directly from direct and full-service suppliers on tender, instead of having products channelled through national and regional administrative levels of the health systems. As reported in a 2015 study on medicines within developing countries, too many tiers in the system was identified as an inefficiency:

> *In most countries [Sub-Saharan Africa] instead of a supply chain design based on technical or operational considerations, the structure of the supply chain is mapped directly to the administrative structure of the health system, p.145 (Yadav 2015)*

Another example can be found with medical devices and equipment (MDE). MDEs are more like AT than medicines in the diversity in product characteristics and need for ongoing maintenance. Like AT, lack of planning and funding for maintenance, repairs and parts is a major barrier to uptake and use of MDEs (Diaconu, Chen et al. 2017). Strategies developed to address this maintenance gap, may be useful in increasing sustained use of AT.

Finally, a major and persistent bottleneck in access to medicines is from the facility/provider to the end user. This important topic was not a focus area of this study though some factors were identified in findings and in other research in Southern Africa (Bozzani, Griffiths et al. 2014, Bright,

Mulwafu et al. 2017, Ennion and Johannesson 2017, Hanass-Hancock, Nene et al. 2017) (i.e., proximity of providers, cost and accessibility of transport, lack of awareness). Without addressing the access gap between the facility/provider to end user, resources invested in strengthening the AT sector may fail to materialize into AT access for the most economically vulnerable and isolated individuals. Home-based and CBR models are a few models that can help bridge this gap (Mannan, Boostrom et al. 2012, Ned, Cloete et al. 2017, Manig 2018, Shumba and Moodley 2018).

Focus on addressing sector inefficiencies over product innovations

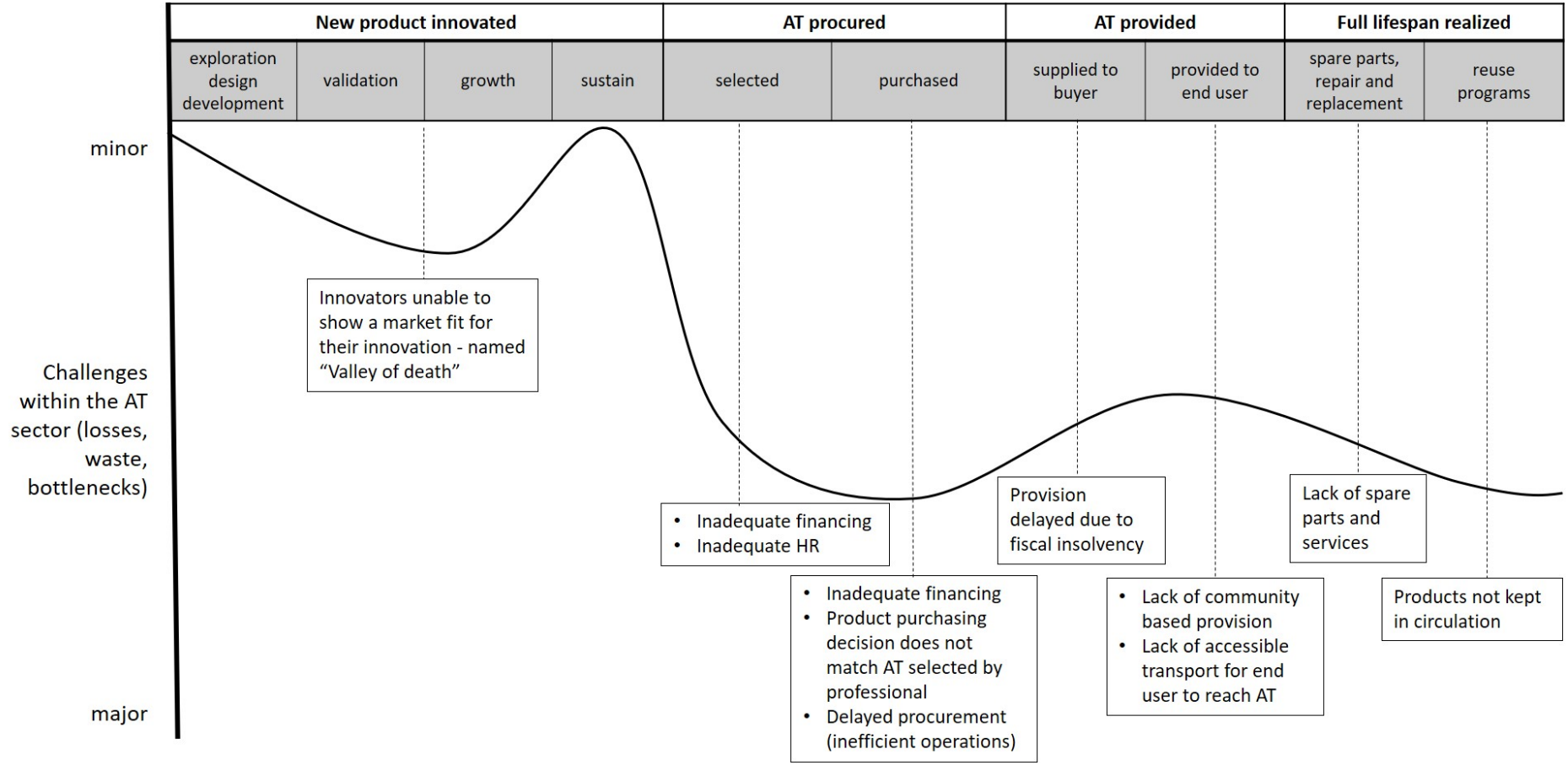
There has been a lot of excitement expressed in the global development community about the potential for new product designs to address the large unmet need, yet the major challenges in Southern Africa will not be address by better and more affordable products alone. Reducing inefficiencies within the sector that limit and delay access to already available AT, made locally or imported, should be the higher priority. The new global initiatives ATscale and AT2030 (ATscale Global Partnership for Assistive Technology 2019, Holloway 2019) both include aims to accelerate product innovations, yet evidence from this study does not indicate that there is a lack of low-cost appropriate AT available on the global markets. Even if specific product types can be reengineered to substantially reduce costs (e.g., power wheelchairs) these new products will be subject to many of the same system-level barriers to access and sustained use.

On the flipside, if new product innovations are implemented in a way that can simultaneously address constraints in the procurement and provision system, this focus makes more sense. For example, if shops that print 3D prosthetics can be located lower levels within the health system (e.g., primary care facility) the travel burden of end users will be reduced.

Another obstacle to realizing the potential of new product innovations are the bottlenecks in getting new products registered for sale within the Southern African market. This bottleneck is also common in medicines and medical devices in South Africa, where backlogs in getting new businesses and products registered can take years (Cameron, Ewen et al. 2009, Saidi and Douglas 2018).

To demonstrate this point further, a model presented on phases on product innovation (Holloway 2019) that was presented at a recent GATE event was adapted to display the four different product phases 1) new AT product innovated, 2) AT procured, 3) AT provided, and 4) full lifespan realized. Figure 7.6 visually displays minor to major challenges within each product phase, in order to show the relative importance of addressing AT system inefficiencies over developing new products. It is important to note that this specific initiative does not solely focus on new product innovation and also aims strengthen procurement processing and address supply chain inefficiencies (Holloway, Chiira et al. 2019).

Figure 7.6 Challenges within the AT sector by phase



Source: R. Matter adapted model of the Innovate Now Ecosystem (Holloway 2019).

Strategic lever 7: Focus on implementation research and knowledge translation

This doctoral study skimmed along operational aspects of the multifaceted AT system. Further research is needed to identify specific practices, capacities and processes across different AT funding sources (Table 6.4) that are most effective and inefficient in increasing access and sustained use of appropriate AT. Some example implementation questions include:

- Which funding mechanisms have the timeliest procurement process? Why?
- Which strategies facilitate timely and affordable provision of spare parts and repairs?
- Which funding sources are best at meeting end user needs/wants (price, best quality, clinical/technical match, choice)? How?
- How do procurement decisions get made (i.e., what level of the organization, which stakeholders, process) (Diaconu, Chen et al. 2017)?
- How to expedite registration of new products (Wouters, Sandberg et al. 2019)?

Implementation research will move the focus to underlying causes of deficits in the AT system, and away from examining user outcomes, service provision and unmet needs that has characterized the evidence base thus far in Southern Africa.

Lastly, synthesis and translation of research findings on how best to increase access, timeliness and sustained use of AT is needed. Given the heterogeneous nature of the evidence base, as found in sub-study 1, meta-analysis and other suitable synthesis methods should be used to synthesis evidence into actionable summaries and tools that are specific to Southern African contexts (Lewin, Glenton et al. 2015).

7.6 LIMITATIONS

Limitations are specific to each of three sub-studies and to the overall approach of my doctoral study. The summary of limitations for sub-study 1 and 2 are described in greater detail at the end of Chapters 3 and 4.

- Sub-study 1. Scoping review: This scoping review originated from a WHO grant that was designed to inform guideline development and aligned with my doctoral research aims. The WHO grant had time and budget restraints which resulted in searching within only four academic databases. The article was published in 2016 thus excluded more recent evidence.
- Sub-study 2. Secondary analysis of national survey data: Datasets from Botswana and Swaziland may not be representative of the Southern African region. In addition, data were collected between 2009-10 is Swaziland and 2012-14 in Botswana so the situation may have changed substantially in the past 5 years. Methodological limitations such as self-reported data being subject to recall and self-report bias could have compromised findings.
- Sub-study 3. Regional qualitative study: A challenge of designing this sub-study was the lack of a systems-level framework specific to the AT sector to build upon. Organizing findings into three components of the AT sector (product supply, AT procurement and provision system, and end users) and five building blocks made sense given the data content but may prove to be too simplistic or not applicable in future studies. Data was biased towards the health sector, mobility devices and AT experiences from South Africa and Zimbabwe. While purposeful sampling was used to increase representation of AT types and countries of experience (see Table 2.1 Participants) most examples provided during interview pertained to mobility devices, wheelchairs specifically, and procurement and provision activities within the health sectors in South Africa or Zimbabwe. Devices for daily living, communication, learning, vision and hearing were all mentioned but comprised a fraction of the data in comparison to mobility devices. However, this emphasis on mobility reflects results in sub-study 2 that shows a greater access for those within mobility limitations. Specific sample and topic gaps identified in retrospect include:
    - Optometrists/optical shop suppliers: Expertise on the supply and access to spectacles and contacts is lacking. Given the saturation of for-profit optical shops throughout Southern Africa, as identified through the AT-Info-Map project (Appendix D), an exploration of the corrective lens industry would have provided unique findings.

- Caregivers and family members: The research design (questions and sampling) did not lend itself to exploring the role of caregivers and family members in accessing and sustaining the use of AT.
- Universal Health Coverage: While this topic was addressed in AT policy documents (e.g., WHA71.8) a central national policy tool to increasing AT access, it was not mentioned by research participants.
- AT for children: Sub-study 2 did not include children (< 15 yrs) in order to include education and economic variables. In sub-study 3, qualitative study, I did not specifically inquire about unique aspects of AT products or system level issues for children. For example, physical growth increases the frequency of times to access AT devices overtime for many types of AT.
- AT experience across the region: While more than half of the interview participants had AT experience in more than one country (12 of 22), the countries that were hardly represented in the data include Zambia, Angola, Congo, and Madagascar (see Chart 2.1).

The breadth of the study topic, AT access within Southern Africa, and design of sub-studies resulted in a broad understanding of the AT sector but not in-depth or comprehensive knowledge about each sub-topic within each building blocks. For example, each one of the AT funding mechanisms warrant their own examination with informants who were well-acquainted with the respective mechanisms (e.g., RAF). Likewise, the policy building block providing a surface level overview of the range of global and national policies that address AT, and general weaknesses within the policy landscape but conducting a thorough policy analyses was outside the scope of this doctoral study.

I do not claim that my research findings or models are generalizable to low resourced regions outside of Southern Africa and may only reflect the realities of a few countries within the region, namely South Africa and Zimbabwe where most the data came from. Data captured parts of the AT sector as each participant and other data did not provide a more holistic understanding of the sector. Combining these pieces to create a complete puzzle (theoretical model) in a highly fragmented sector was challenging. The interpretation I settled upon was driven by the aim to inform recommendations to increase AT access. Major constraints and strategic levers were described but this thesis did not achieve a comprehensive theoretical model of how the AT sector operates to increase access in Southern Africa as initially proposed. The strategic levers, which included many of recommendations from sub-study 1 and 2, were informed by the evidence and influenced by my opinion. The casual diagrams, conceptual models and recommendations generated by this study warrant critique and further development.

7.7 CONCLUSION

For most people who need AT in Southern Africa, it is unavailable, unaffordable, inappropriate and lacks services and spare parts to sustain usage. Of the limited AT products and services provided by government, non-profit and for-profit sources; most are mobility devices. The type of disability (i.e., mobility vs. non-mobility) was found to be the most important factor in determining AT access when examining a range of sociodemographic variables. This asymmetry in AT access reflects the disproportional amount of resources directed towards mobility AT, globally and nationally.

Lack of timely access and sustained use of appropriate AT emerged as key end user experiences. Unmet user needs result from several sector wide weaknesses within the product supply, and procurement and provision system. Constraints and underlying patterns with the five building blocks of the AT system were synthesized and pointed to two high level patterns that compromise advancing of the sector. The first pattern, low prioritization of AT, was primarily driven by lack of awareness, and identified as a root cause of system-level weaknesses. The second pattern, high level of fragmentation, was most noticeable across financing mechanisms and policies. Fragmentation results from the heterogenous nature of AT and piecemeal approaches taken by actors within government, for-profits and non-profits that have shaped this young industry within Southern African countries.

The synthesis of evidence showed that AT in Southern Africa does not operate as a sector but as a constellation of uncoordinated parts and has a high level of waste. This means that the limited resources invested in funding AT products and services, and in strengthening national AT systems have not been used effectively to increase AT supply and access. Most sources of waste can be corrected by how national AT systems and supporting transnational and national structures are designed. Yet waste that results from broader infrastructural and economic inefficiencies such as costly transnational shipping/border processing or fluctuating exchange rates seem intractable, and at best can only be minimized.

In looking forward, I described seven strategic levers that aim to increase resources invested in the AT sector while reducing inefficiencies. These levers, derived from study findings, seek to address the overarching question that motivated this doctoral study, what works to increase access to assistive technology in Southern Africa? While the response to this core research question will often depend on the specific products, sectors and contexts; the levers identified aim to address the AT as a unified sector. Strategic levers are not prescriptive but presented as general approaches and include both potential solutions and critiques of existing strategies. What is consistent across these

levers is the attempt to create consistency and structures within an amorphous and incongruous sector, beginning with the fundamental awareness raising of *what is possible* (range of AT, potential beneficiaries). How best to bring shape and harmonize the Southern African AT sector accommodate for the inherent complexity of AT products is the balancing act that these levers try to achieve.

Another approach to answering the core research question is found in the partial solutions implemented by a few organizations or influential individuals. Small-scale solutions identified by participants have been woven throughout the thesis (e.g., NGOs stop donating AT, MOH procure spare parts with devices on tender and implement a community level reuse program). These small efforts will continue to increase AT access incrementally and can be bolstered by external support.

The current top down approaches that start with global AT policies that are then domesticated at the national level face numerous challenges. Recent global policies explicitly frame AT broadly, with a wide range of product types, beneficiaries and as multisectoral (e.g., health, education, employment) . However, the global discourse often defaults to the narrow discussion of mobility devices provided within the health system by rehabilitation professionals. The complexity of products and fragmentation within the sector puts an increased demand on the global community to customize, translate and provide technical assistance so that global policy instruments are implementable. Implementation requires flexibility to ensure policy instruments match diverse national structures, product segments and capacity levels.

Multisectoral models to guide conceptual or applied work, that are flexible enough to accommodate the wide range of AT characteristics we not identified through this study. The original aim of this study was to develop a comprehensive theoretical model on how to increase AT access with Southern Africa. Instead, a series of causal maps and conceptual models were developed that illuminate the complexities within the AT sector and identify how strategic levers can shift the sector towards increased access in Southern Africa.

In closing, I believe that this study has made a timely contribution to the field of AT, to both the global conversation and to inform actionable strategies in Southern Africa. As evident from this study, AT as a sector is in its' infancy with tremendous potential for growth to address unmet needs across Southern Africa. I hope that the insights presented in this study on how best to stimulate and manage that growth will be of use to influence government, non-profit and for-profit actors in this field. At all levels, from global to national, knowledge sharing is critical to advancing the understanding of AT as a sector, replicating the solutions that are working and unifying fragmented parts. Assisting in the creation of transnational platforms for knowledge sharing a form of support that the global community can provide to help the AT sector mature within Southern Africa.

APPENDICES A-F

APPENDIX A: SCOPING REVIEW TABLES AND INCLUDED PUBLICATION LIST (CHAPTER 3)

Scoping review search strings

Table A.1 Search terms for Concept A 'AND' Concept B

Database	CONCEPT A: Assistive Technology All relevant terms by topics below linked by 'OR'	CONCEPT B: Resource limited environment All relevant terms by topics below linked by 'OR'
Pubmed	("Self-Help Devices"[Mesh] OR "Durable Medical Equipment"[Mesh] OR "sensory aids"[MeSH Terms] OR "orthotic devices"[MeSH Terms] OR "artificial limbs"[MeSH Terms] OR "hearing aids"[MeSH Terms] OR "canes"[MeSH Terms] OR "eyeglasses"[MeSH Terms] OR "wheelchairs"[MeSH Terms] OR "walkers"[MeSH Terms] OR "canes"[MeSH Terms] OR "crutches"[MeSH Terms] OR "dependent ambulation"[MeSH] OR "speech recognition software"[MeSH Terms] OR "architectural accessibility"[MeSH Terms] OR ("assistive device"[tiab] OR "assistive devices"[tiab] OR "assistive technology"[tiab] OR "assistive product"[tiab] OR "assistive	((((("developing country"[tiab] OR "developing countries"[tiab] OR "developing nation"[tiab] OR "developing nations"[tiab] OR "developing population"[tiab] OR "developing populations"[tiab] OR "developing world"[tiab] OR "less developed country"[tiab] OR "less developed countries"[tiab] OR "less developed nations"[tiab] OR "less developed world"[tiab] OR "lesser developed countries"[tiab] OR "lesser developed nations"[tiab] OR "under developed country"[tiab] OR "under developed countries"[tiab] OR "under developed nations"[tiab] OR "under developed world"[tiab] OR "underdeveloped country"[tiab] OR "underdeveloped countries"[tiab] OR "underdeveloped nations"[tiab] OR "underdeveloped population"[tiab] OR "underdeveloped world"[tiab] OR "middle income country"[tiab] OR "middle income countries"[tiab] OR "middle income nation"[tiab] OR "middle income nations"[tiab] OR "middle income population"[tiab] OR "middle income populations"[tiab] OR "low income country"[tiab] OR "low income countries"[tiab] OR "low income nations"[tiab] OR "low income population"[tiab] OR "low income populations"[tiab] OR "lower income country"[tiab] OR "lower income countries"[tiab] OR "lower income nations"[tiab] OR "lower income population"[tiab] OR "lower income populations"[tiab] OR "underserved countries"[tiab] OR "underserved nations"[tiab] OR "underserved population"[tiab] OR "underserved populations"[tiab] OR "under served population"[tiab] OR "under served populations"[tiab] OR "deprived countries"[tiab] OR "deprived population"[tiab] OR "deprived populations"[tiab] OR "poor country"[tiab] OR "poor countries"[tiab] OR "poor nation"[tiab] OR "poor nations"[tiab] OR "poor population"[tiab] OR "poor populations"[tiab] OR "poor world"[tiab] OR "poorer countries"[tiab] OR "poorer nations"[tiab] OR "poorer

Database	CONCEPT A: Assistive Technology All relevant terms by topics below linked by 'OR'	CONCEPT B: Resource limited environment All relevant terms by topics below linked by 'OR'
	products"[tiab] OR "technical aid"[tiab] OR "technical aids"[tiab] OR "Braille"[tiab] OR "commodes"[tiab] OR "buggies"[tiab] OR "cognitive aid"[tiab] OR "universal design"[tiab])	population"[tiab] OR "poorer populations"[tiab] OR "developing economy"[tiab] OR "developing economies"[tiab] OR "less developed economies"[tiab] OR "underdeveloped economies"[tiab] OR "middle income economies"[tiab] OR "low income economies"[tiab] OR "low gdp"[tiab] OR "low gnp"[tiab] OR "low gross domestic"[tiab] OR "low gross national"[tiab] OR "lower gdp"[tiab] OR lmic[tiab] OR lmics[tiab] OR "third world"[tiab] OR "lami country"[tiab] OR "lami countries"[tiab] OR "transitional country"[tiab] OR "transitional countries"[tiab]) OR ("developing countries"[MeSH Terms] OR "poverty areas"[MeSH Terms] OR "poverty"[MeSH Terms] OR "vulnerable populations"[MeSH Terms] OR "medically underserved area"[MeSH Terms])) OR All low- or middle-income countries by the World Bank Country Classification were searched for TIAB (http://data.worldbank.org/about/country-and-lending-groups)
EMBASE	'assistive device':ab,ti OR 'assistive devices':ab,ti OR 'assistive technology':ab,ti OR 'assistive product':ab,ti OR 'technical aid':ab,ti OR 'braille':ab,ti OR 'commodes':ab,ti OR 'buggies':ab,ti OR 'cognitive aid':ab,ti OR 'universal design':ab,ti 'assistive technology'/exp OR 'assistive technology device'/exp OR 'exoskeleton (rehabilitation)'/exp OR 'technical aid'/exp OR 'blind mobility aid'/exp OR 'orthosis'/exp OR 'limb prosthesis'/exp OR 'orthopedic therapeutic device'/exp OR 'sensory aid'/exp OR 'hearing aid'/exp OR 'visual aid'/exp OR 'braille'/exp OR 'optical visual aid'/exp OR 'communication aid'/exp OR	'developing country'/exp OR 'medically underserved'/exp OR 'poverty'/exp OR 'lowest income group'/exp OR 'developing country':ab,ti OR 'developing countries':ab,ti OR 'developing nation':ab,ti OR 'developing nations':ab,ti OR 'developing population':ab,ti OR 'developing populations':ab,ti OR 'developing world':ab,ti OR 'less developed country':ab,ti OR 'less developed countries':ab,ti OR 'less developed nations':ab,ti OR 'less developed world':ab,ti OR 'lesser developed countries':ab,ti OR 'lesser developed nations':ab,ti OR 'under developed country':ab,ti OR 'under developed countries':ab,ti OR 'under developed nations':ab,ti OR 'under developed world':ab,ti OR 'underdeveloped country':ab,ti OR 'underdeveloped countries':ab,ti OR 'underdeveloped nations':ab,ti OR 'underdeveloped population':ab,ti OR 'underdeveloped world':ab,ti OR 'middle income country':ab,ti OR 'middle income countries':ab,ti OR 'middle income nation':ab,ti OR 'middle income nations':ab,ti OR 'middle income population':ab,ti OR 'middle income populations':ab,ti OR 'low income country':ab,ti OR 'low income countries':ab,ti OR 'low income nations':ab,ti OR 'low income population':ab,ti OR 'low income populations':ab,ti OR 'lower income country':ab,ti OR 'lower income countries':ab,ti OR 'lower income nations':ab,ti OR 'lower income population':ab,ti OR 'lower income populations':ab,ti OR 'underserved countries':ab,ti OR 'underserved nations':ab,ti OR 'underserved population':ab,ti OR 'underserved populations':ab,ti OR 'under served population':ab,ti OR 'under served populations':ab,ti OR 'deprived countries':ab,ti OR 'deprived population':ab,ti OR 'deprived populations':ab,ti OR 'poor

Database	CONCEPT A: Assistive Technology All relevant terms by topics below linked by 'OR'	CONCEPT B: Resource limited environment All relevant terms by topics below linked by 'OR'
	'facilitated communication'/exp OR 'walking aid'/exp	country':ab,ti OR 'poor countries':ab,ti OR 'poor nation':ab,ti OR 'poor nations':ab,ti OR 'poor population':ab,ti OR 'poor populations':ab,ti OR 'poor world':ab,ti OR 'poorer countries':ab,ti OR 'poorer nations':ab,ti OR 'poorer population':ab,ti OR 'poorer populations':ab,ti OR 'developing economy':ab,ti OR 'developing economies':ab,ti OR 'less developed economies':ab,ti OR 'underdeveloped economies':ab,ti OR 'middle income economies':ab,ti OR 'low income economies':ab,ti OR 'low gdp':ab,ti OR 'low gnp':ab,ti OR 'low gross domestic':ab,ti OR 'low gross national':ab,ti OR 'lower gdp':ab,ti OR lmic:ab,ti OR lmics:ab,ti OR 'third world':ab,ti OR 'lami country':ab,ti OR 'lami countries':ab,ti OR 'lic country':ab,ti OR 'lic countries':ab,ti OR 'ldc country':ab,ti OR 'ldc countries':ab,ti OR 'transitional country':ab,ti OR 'transitional countries':ab,ti OR All low- or middle-income countries by the World Bank Country Classification were searched for TIAB (http://data.worldbank.org/about/country-and-lending-groups)
CINAHL	(MM "Assistive Technology Devices+") OR (MM "Ambulation Aids+") OR (MM "Communication Aids for Disabled+") OR (MM "Limb Prosthesis") OR (MM "Wheelchairs+") OR (MM "Sensory Aids+") OR (MM "Assistive Technology Services") OR (MM "Lenses+") OR (MM "Alternative and Augmentative Communication") OR (MM "Braille") OR (MM "Orthoses+") OR (MH "Architectural Accessibility") OR (MH "Voice Recognition Systems") OR TI (assistive device* OR assistive technology OR assistive product* OR technical aid* OR commode* OR buggies OR cognitive aid*OR	(MH "Developing Countries") OR (MH "Poverty Areas") OR (MH "Poverty+") OR (MH "Health Services for the Indigent") OR (MH "Indigent Persons") OR (MH "Medically Underserved") OR (MH "Medically Underserved Area") OR AB ("developing country" OR "developing countries" OR "developing nation" OR "developing nations" OR "developing population" OR "developing populations" OR "developing world" OR "less developed country" OR "less developed countries" OR "less developed nations" OR "less developed world" OR "lesser developed countries" OR "lesser developed nations" OR "under developed country" OR "under developed countries" OR "under developed nations" OR "under developed world" OR "underdeveloped country" OR "underdeveloped countries" OR "underdeveloped nations" OR "underdeveloped population" OR "underdeveloped world" OR "middle income country" OR "middle income countries" OR "middle income nation" OR "middle income nations" OR "middle income population" OR "middle income populations" OR "low income country" OR "low income countries" OR "low income nations" OR "low income population" OR "low income populations" OR "lower income country" OR "lower income countries" OR "lower income nations" OR "lower income population" OR "lower income populations" OR "underserved countries" OR "underserved nations" OR "underserved population" OR "underserved populations" OR "under served population" OR "under served populations" OR "deprived countries" OR

Database	CONCEPT A: Assistive Technology All relevant terms by topics below linked by 'OR'	CONCEPT B: Resource limited environment All relevant terms by topics below linked by 'OR'
	universal design) OR AB (assistive device* OR assistive technology OR assistive product* OR technical aid* OR commode* OR buggies OR cognitive aid*OR universal design)	"deprived population" OR "deprived populations" OR "poor country" OR "poor countries" OR "poor nation" OR "poor nations" OR "poor population" OR "poor populations" OR "poor world" OR "poorer countries" OR "poorer nations" OR "poorer population" OR "poorer populations" OR "developing economy" OR "developing economies" OR "less developed economies" OR "underdeveloped economies" OR "middle income economies" OR "low income economies" OR "low gdp" OR "low gnp" OR "low gross domestic" OR "low gross national" OR "lower gdp" OR lmic OR lmics OR "third world" OR "lami country" OR "lami countries" OR "lic country" OR "lic countries" OR "ldc country" OR "ldc countries" OR "transitional country" OR "transitional countries") OR TI (same terms as above) OR All low- or middle-income countries by the World Bank Country Classification were searched for TIAB (http://data.worldbank.org/about/country-and-lending-groups)
COCHRANE	Same as pubmed	Same as pubmed

Table A.2 Search terms for Concept C 'AND' Concept D

Database	CONCEPT C: Disability All relevant terms by topics below linked by 'OR'	CONCEPT D: Broad terms to capture AT when paired with CONCEPT C All relevant terms by topics below linked by 'OR'
Pubmed	("disabled persons"[MeSH Terms] OR "hearing disorders"[MeSH Terms] OR "vision disorders"[MeSH Terms] OR "mental disorders diagnosed in childhood"[MeSH Terms] OR "communication disorders"[MeSH Terms] OR "memory disorders"[MeSH Terms] OR "pressure ulcer"[MeSH Terms]) OR (disability[tiab] OR disabilities[tiab] OR disabled[tiab])	("equipment design"[MeSH Terms] OR "technology"[MeSH Terms] OR "equipment safety"[MeSH Terms] OR "software"[MeSH Terms] OR "computers"[MeSH Terms] OR "user-computer interface"[MeSH Terms] OR "posture"[MeSH Terms] OR "patient positioning"[MeSH Terms] OR "reminder systems"[MeSH Terms])
EMBASE	'disability'/exp OR 'disabled person'/exp OR 'hearing impairment'/exp OR 'visual impairment'/exp OR 'communication disorder'/exp OR 'psychomotor disorder'/exp OR 'developmental disorder'/exp OR 'learning	'equipment design'/exp OR 'technology'/exp OR 'device safety'/exp OR 'computer program'/exp OR 'computer interface'/exp OR 'body position'/exp OR 'information system'/exp

Database	CONCEPT C: Disability All relevant terms by topics below linked by 'OR'	CONCEPT D: Broad terms to capture AT when paired with CONCEPT C All relevant terms by topics below linked by 'OR'
	disorder'/exp OR 'motor dysfunction'/exp OR 'decubitus'/exp OR 'disability':ab,ti OR 'disabilities':ab,ti OR 'disabled':ab,ti	
CINAHL	(MH "Mentally Disabled Persons") OR (MH "Parents of Disabled Children") OR (MH "Students, Disabled") OR (MH "Parents, Disabled") OR (MH "Child, Disabled") OR (MH "Athletes, Disabled") OR (MH "Amputees") OR (MH "Disabled+") OR (MH "Hearing Disorders+") OR (MH "Hearing Loss, Partial+") OR (MH "Deafness+") OR (MH "Vision Disorders+") OR (MH "Blindness+") OR (MH "Deaf-Blind Disorders+") OR (MH "Child Development Disorders+") OR (MH "Mental Disorders Diagnosed in Childhood+") OR (MH "Developmental Disabilities") OR (MH "Learning Disorders+") OR (MH "Mental Retardation") OR (MH "Communicative Disorders+") OR (MH "Child Development Disorders, Pervasive+") OR (MH "Child Behavior Disorders+") OR (MH "Pressure Ulcer+") OR AB (disability OR disabilities OR disabled) OR TI (disability OR disabilities OR disabled)	(MH "Equipment Design+") OR (MH "Equipment Safety") OR (MH "Technology+") OR (MH "Computer Systems+") OR (MH "Body Positions+") OR (MH "Reminder Systems")
COCHRANE	Same as pubmed	Same as pubmed

Table A.3 Search terms excluded within each database

Database	NOT search terms
Pubmed	("Dentistry"[Mesh terms] OR "cochlear implants"[Mesh] OR "cochlear"[tiab] OR "dental"[tiab])
EMBASE	'auditory implant'/exp OR 'dentistry'/exp OR 'cochlear':ab,ti OR 'dental':ab,ti
CINAHL	(MH "Cochlear Implant+") OR (MH "Dentistry+") OR AB (cochlear OR dental) OR TI (cochlear OR dental)
COCHRANE	(dental or cochlear):ti,ab,kw

COUNTRY/REGION LIST:

Regions and countries identified as low or middle income countries by the World Bank Country Classification - http://data.worldbank.org/about/country-classifications OR Africa[tiab] OR Asia[tiab] OR Caribbean[tiab] OR West Indies[tiab] OR South America[tiab] OR Latin America[tiab] OR Central America[tiab]))Scoping review exclusion criteria coding

Scoping review exclusion criteria coding

Table A.4 Exclusion coding

Exclusion Coding	
E1=Not AT	AT is not one of the primary topics of research AT is only a characteristic of study population but primary research topic is not about AT (e.g., mental health outcome of wheelchair users) Non-AT related topics: Vocational training/rehabilitation Endoprosthesis (arthroplasty/joint prosthesis, ligament prosthesis) Osseointegration Implants including cochlear Casts and noninvasive traction devices Orthopedic diagnostic devices Orthopedic fixation devices (casts, nails) Medical devices not rehabilitation related Sign language, lip-reading Dental related technology Information and communication technologies (ICTs) non-disability related Home care services and personal assistance non-disability-related Cataracts surgery Intraocular lenses, aphakic spectacles, therapeutic contact lenses Contact lens related to Keratoconus, keratitis or infections Contact lens care, cleaning, hygiene Contact lens related corneal ulcers Hearing aid care, cleaning Eye surgery, contact use after surgery (e.g., LASIK) Robotic training devices, gait training Protective eyewear Braces, spinal orthotics, gait orthosis Visual prosthesis Brain-computer interface technology
E2=Not RLE	Does not focus on resource limited setting or resource limited population
E3=Not research or systematic review (i.e., no evidence)	Excluded research type: Theoretical, strictly prevalence studies, R & D study that only reports on early development phase, untested concept description, patents Research that reports on testing/validation of outcome measures, surveys, instruments related to AT Studies with insufficient information to allow for adequate interpretation of results/findings Excluded document type: Editorials/commentaries/letters, abstracts only, bibliographies, Book Reviews, author replies
E4=Vague	Study title is vague, or no abstract is provided so not able to determine if focus meets inclusion criteria

Scoping review detailed search results

Table A.5 PubMed search results

Concept A 'AND'	Concept B 'AND'	Table 1 Results
45444	958702	1027

Concept C 'AND'	Concept D 'AND'	Concept B	Table 2 Results
430792	623523	958702	248

Table 1 Results 'OR'	Table 2 Results	WP5 Results
1027	248	1257
EXCLUSION	# excluded	
NOT terms	196	1061
Filters: Human/2000-present	92	969
	326	643
FINAL (12/4/2013)	614	**643**

Table A.6 EMBASE search results

Concept A 'AND'	Concept B 'AND'	Table 1 Results
70197	1052350	1815

Concept C 'AND'	Concept D 'AND'	Concept B	Table 2 Results
902628	526346	1052350	784

Table 1 Results 'OR'	Table 2 Results	WP5 Results
1815	784	2530
EXCLUSION	# excluded	
NOT terms	357	2173
Filters: human/2000-present	574	1599
Filters: exclude letters, notes	34	1565
FINAL (12/7/2013)	3 duplicates - endnote	**1562**

Table A.7 CINAHL search results

Concept A 'AND'	Concept B 'AND'	Table 1 Results
27517	132159	477

Concept C 'AND'	Concept D 'AND'	Concept B	Table 2 Results
164352	305443	132159	762

Table 1 Results 'OR'	Table 2 Results	WP5 Results
477	762	1170
EXCLUSION	# excluded	

NOT terms: cochlear, dental	102	1068
Filter: 2000-present/human	255	813
Filter: instrument validation	40	773
FINAL (12/12/2013)		**773**

Table A.8 Cochrane search results

Concept A 'AND'	Concept B 'AND'	Table 1 Results
2705	22512	111

Concept C 'AND'	Concept D 'AND'	Concept B	Table 2 Results
17622	14641	22512	12

Table 1 Results 'OR'	Table 2 Results	WP5 Results
111	12	122
EXCLUSION	# excluded	
NOT terms: cochlear, dental	2	120
Filter: 2000-present	17	103
FINAL (12/12/2013)		**103**

References of 252 publications included in the scoping review

1. Ahmad A. Prosthetic problems of transtibial amputee. Journal of Postgraduate Medical Institute 2009;23(2):153-158.
2. Alant E, Life H, Harty M. Comparison of the learnability and retention between Blissymbols and CyberGlyphs. International Journal of Language & Communication Disorders 2005;40(2):151-169.
3. Amedofu GK, Awuah P, Ocansey G, Antwi B, Brobby GW. Utilization of hearing aids by the hearing-impaired in Ghana. Tropical Doctor 2004;34(2):118-120.
4. Andrysek J. Lower-limb prosthetic technologies in the developing world: A review of literature from 1994-2010. Prosthetics and Orthotics International 2010;34(4):378-98.
5. Andrysek J, Klejman S, Torres-Moreno R, Heim W, Steinnagel B, Glasford S. Mobility function of a prosthetic knee joint with an automatic stance phase lock. Prosthetics & Orthotics International (Taylor & Francis Ltd) 2011;35(2):163-170.
6. Armstrong W, Reisinger KD, Smith WK. Evaluation of CIR-Whirlwind Wheelchair and service provision in Afghanistan. Center for International Rehabilitation. Disability & Rehabilitation 2007;29(11-12):935-948.
7. Authier EL, Pearlman J, Allegretti AL, Rice I, Cooper RA. A sports wheelchair for low-income countries. Disability & Rehabilitation 2007;29(11-12):963-967.
8. Ayanniyi AA, Folorunso FN, Adepoju FG. Refractive ocular conditions and reasons for spectacles renewal in a resource-limited economy. BMC ophthalmology 2010;10:12.
9. Baltussen R, Li J, Wu LD, Ge XH, Teng BY, Sun XB, Han R, Wang XL, McPherson B. Costs of screening children for hearing disorders and delivery of hearing aids in China. BMC Health Services Research 2009;9.
10. Baltussen R, Smith A. Cost-effectiveness of selected interventions for hearing impairment in Africa and Asia: A mathematical modelling approach. International Journal of Audiology 2009;48(3):144-158.

11. Bastawrous A, Mathenge W, Foster A, Kuper H. Prevalence and predictors of refractive error and spectacle coverage in Nakuru, Kenya: a cross-sectional, population-based study. International Ophthalmology 2013:1-8.
12. Bengisu M. Assistive technologies for visually impaired individuals in Turkey. Assistive Technology 2010;22(3):163-171.
13. Bento RF, Penteado SP. Designing of a digital behind-the-ear hearing aid to meet the World Health Organization requirements. Trends in amplification 2010;14(2):64-72.
14. Berry JL, Cuzzo LM, Bababeygy SR, Quiros PA. Unmet need for corrective eyeglasses: results from a Los Angeles County Hospital survey. Int Ophthalmol 2012;32(3):245-50.
15. Beyene NM, Steinfeld A, Pearlman J, Cooper RA. Exploration of health perceptions and assistive technology use by driving status as related to transportation independence in New Delhi, India. Disability and Rehabilitation: Assistive Technology 2012;7(4):314-322.
16. Bhaskaranand K, Bhat AK, Acharya KN. Prosthetic rehabilitation in traumatic upper limb amputees (an Indian perspective). Archives of Orthopaedic and Trauma Surgery 2003;123(7):363-366.
17. Bhattacharya S, Basu A. Design of an iconic communication aid for individuals in India with speech and motion impairments. Assistive technology : the official journal of RESNA 2009;21(4):173-187.
18. Bigelow J, Korth M, Jacobs J, Anger N, Riddle M, Gifford J. A picture of amputees and the prosthetic situation in Haiti. Disability and Rehabilitation 2004;26(4):246-252.
19. Borg J, Larsson S, Ostergren PO, Rahman AA, Bari N, Khan AN. Assistive technology use and human rights enjoyment: A cross-sectional study in Bangladesh. BMC International Health and Human Rights 2012;12(1).
20. Borg J, Larsson S, Ostergren PO, Rahman AS, Bari N, Khan AH. User involvement in service delivery predicts outcomes of assistive technology use: a cross-sectional study in Bangladesh. BMC health services research 2012;12:330.
21. Borg J, Lindstrom A, Larsson S. Assistive technology in developing countries: a review from the perspective of the Convention on the Rights of Persons with Disabilities. Prosthetics and Orthotics International 2011;35(1):20-9.
22. Borg J, Ostergren PO, Larsson S, Rahman AA, Bari N, Khan AN. Assistive technology use is associated with reduced capability poverty: A cross-sectional study in Bangladesh. Disability and Rehabilitation: Assistive Technology 2012;7(2):112-121.
23. Bornman J, Alant E, Du Preez A. Translucency and learnability of Blissymbols in Setswana-speaking children: an exploration. Augmentative and alternative communication (Baltimore, Md.: 1985) 2009;25(4):287-298.
24. Bourne RRA, Dineen BP, Noorul Huq DM, Ali SM, Johnson GJ. Correction of Refractive Error in the Adult Population of Bangladesh: Meeting the Unmet Need. Investigative Ophthalmology and Visual Science 2004;45(2):410-417.
25. Brady CJ, Villanti AC, Gandhi M, Friedman DS, Keay L. Visual function after correction of distance refractive error with ready-made and custom spectacles: A randomized clinical trial. Ophthalmology 2012;119(10):2014-2020.
26. Buated W, Sriyudthsak M, Sribunruangrit N, Bhidayasiri R. A low-cost intervention for improving gait in Parknson's disease patients: A cane providing visual cues. European Geriatric Medicine 2012;3(2):126-130.
27. Burger H, Marincek C, Jaeger RJ. Prosthetic Device Provision to Landmine Survivors in Bosnia and Herzegovina: Outcomes in 3 Ethnic Groups. Archives of Physical Medicine and Rehabilitation 2004;85(1):19-28.
28. Campbell AI, Sexton S, Schaschke CJ, Kinsman H, McLaughlin B, Boyle M. Prosthetic limb sockets from plant-based composite materials. Prosthetics and Orthotics International 2012;36(2):181-9.
29. Campbell DJT, Coll N, Thurston WE. Considerations for the provision of prosthetic services in post-disaster contexts: the Haiti Amputee Coalition. Disability & Society 2012;27(5):647-661.
30. Campos PD, Ferrari DV. Teleaudiology: Evaluation of teleconsultation efficacy for hearing aid fitting. Jornal da Sociedade Brasileira de Fonoaudiologia 2012;24(4):301-308.

31. Castanon Holguin AM, Congdon N, Patel N, Ratcliffe A, Esteso P, Toledo Flores S, Gilbert D, Pereyra Rito MA, Munoz B. Factors associated with spectacle-wear compliance in school-aged Mexican children. Investigative Ophthalmology and Visual Science 2006;47(3):925-928.
32. Chan VF, Mebrahtu G, Ramson P, Wepo M, Naidoo KS. Prevalence of refractive error and spectacle coverage in Zoba Ma'ekel Eritrea: A rapid assessment of refractive error. Ophthalmic Epidemiology 2013;20(3):131-137.
33. Cheng CM, McPherson B. Over-the-counter hearing aids: electroacoustic characteristics and possible target client groups. Audiology 2000;39(2):110-6.
34. Christy B, Nirmalan PK. Acceptance of the long cane by persons who are blind in South India. Journal of Visual Impairment & Blindness 2006;100(2):115-119.
35. Ciobanu O. [The use of CAD/CAM and rapid fabrication technologies in prosthesis and orthotics manufacturing]. Revista medico-chirurgicală a Societăţii de Medici şi Naturalişti din Iaşi. 2012;116(2):642-648.
36. Collins DM, Karmarkar A, Relich R, Pasquina PF, Cooper RA. Review of research on prosthetic devices for lower extremity amputation. Critical Reviews in Biomedical Engineering 2006;34(5):379-438.
37. Congdon N, Li L, Zhang M, Yang A, Gao Y, Griffiths S, Wu J, Sharma A, Lam DSC. Randomized, controlled trial of an educational intervention to promote spectacle use in rural China: The see well to learn well study. Ophthalmology 2011;118(12):2343-2350.
38. Congdon NG, Patel N, Esteso P, Chikwembani F, Webber F, Msithini RB, Ratcliffe A. The association between refractive cutoffs for spectacle provision and visual improvement among school-aged children in South Africa. British Journal of Ophthalmology 2008;92(1):13-18.
39. Convery E, Keidser G, Caposecco A, Swanepoel DW, N, Shen E. Hearing-aid assembly management among adults from culturally and linguistically diverse backgrounds: Toward the feasibility of self-fitting hearing aids. International Journal of Audiology 2013;52(6):385-393.
40. Convery E, Keidser G, Hartley L, Caposecco A, Hickson L, Meyer C. Management of hearing aid assembly by urban-dwelling hearing-impaired adults in a developed country: implications for a self-fitting hearing aid. Trends in amplification 2011;15(4):196-208.
41. Dalcoll MW, Alves MR, Barreto Jr J, Yamane IS, Bechara S, Mukai A. Evaluation of optical performance of soft contact lenses in myopic correction. Arquivos brasileiros de oftalmologia 2008;71(6 Suppl):37-41.
42. Dandona R, Dandona L, Kovai V, Giridhar P, Prasad MN, Srinivas M. Population-based study of spectacles use in southern India. Indian journal of ophthalmology 2002;50(2):145-155.
43. de Almeida F, de, Anders JC, JatobÃ¡ de I, Rocha PcK. Perception of the child and adolescent in relation to being dependent on technology: fundamental aspects for nursing care [Portuguese]. Texto & Contexto Enfermagem 2013;22(2):343-351.
44. De Freitas Alves CC, Monteiro GBM, Rabello S, Gasparetto MERF, De Carvalho KM. Assistive technology applied to education of students with visual impairment. Revista Panamericana de Salud Publica/Pan American Journal of Public Health 2009;26(2):148-152.
45. de Oliveira Assis L, Tirado MG, de Melo Pertence AE, Pereira LS, Mancini MC. Evaluation of cognitive technologies in geriatric rehabilitation: a case study pilot project. Occupational therapy international 2010;17(2):53-63.
46. Dogan A, Mengulluoglu M, Ozgirgin N. Evaluation of the effect of ankle-foot orthosis use on balance and mobility in hemiparetic stroke patients. Disabil Rehabil 2011;33(15-16):1433-9.
47. Douali MG, Silver JD. Self-optimised vision correction with adaptive spectacle lenses in developing countries. Ophthalmic and Physiological Optics 2004;24(3):234-241.
48. Dusing SC, Skinner AC, Mayer ML. Unmet need for therapy services, assistive devices, and related services: Data from the National Survey of Children with Special Health Care Needs. Ambulatory Pediatrics 2004;4(5):448-454.

49. Efron N, Morgan PB, Woods CA, Awasthi S, Belousov V, Bendo-rienen J, Chandrinos A, Chane P, Sun Chu B, Davila-Garcia E and others. An international survey of daily disposable contact lens prescribing. Clinical and Experimental Optometry 2013;96(1):58-64.
50. Efron N, Morgan PB, Woods CA, International Contact Lens Prescribing Survey C. Survey of contact lens prescribing to infants, children, and teenagers. Optometry and vision science : official publication of the American Academy of Optometry 2011;88(4):461-468.
51. Efron N, Morgan PB, Woods CA, International Contact Lens Prescribing Survey C. International survey of contact lens prescribing for extended wear. Optometry and vision science : official publication of the American Academy of Optometry 2012;89(2):122-129.
52. Efron N, Morgan PB, Woods CA, International Contact Lens Prescribing Survey C. International survey of rigid contact lens fitting. Optometry and vision science : official publication of the American Academy of Optometry 2013;90(2):113-118.
53. Ehrlich NJ, Carlson D, Bailey N. Sources of Information about How to Obtain Assistive Technology: Findings from a National Survey of Persons with Disabilities. Assistive Technology 2003;15(1):28-38.
54. Eliah E, Shayo A, Gendo C, Courtright P, Theraney M, Lewallen S. Can VISION 2020 be implemented in rural government settings? Findings from two programmes in Tanzania. Tropical Medicine and International Health 2008;13(10):1284-1287.
55. Eshraghi Aa, Osman, N.A.A.a , Gholizadeh, H.a , Karimi, M.b , Ali, S.a Pistoning assessment in lower limb prosthetic sockets. Prosthetics and Orthotics International 2012;36(1):15-24.
56. Esteso P, Castanon A, Toledo S, Pereyra Rito MA, Ervin A, Wojciechowski R, Congdon NG. Correction of moderate myopia is associated with improvement in self-reported visual functioning among Mexican school-aged children. Investigative Ophthalmology and Visual Science 2007;48(11):4949-4954.
57. Ezelum C, Razavi H, Sivasubramaniam S, Gilbert CE, Murthy GVS, Entekume G, Abubakar T. Refractive error in nigerian adults: Prevalence, type, and spectacle coverage. Investigative Ophthalmology and Visual Science 2011;52(8):5449-5456.
58. Ferrari DV, Bernardez-Braga GRA. Remote probe microphone measurement to verify hearing aid performance. Journal of Telemedicine and Telecare 2009;15(3):122-124.
59. Freixes O, Fernandez SA, Crespo MJ, Gatti MA, Muzio D, Olmos LE. Wheelchair axle position effect on tetraplegic propulsion performance. Neurologia Argentina 2012;4(1):22-26.
60. Freixes O, Fernandez SA, Gatti MA, Crespo MJ, Olmos LE, Rubel IF. Wheelchair axle position effect on start-up propulsion performance of persons with tetraplegia. Journal of Rehabilitation Research and Development 2010;47(7):661-668.
61. Frick KD, Riva-Clement L, Shankar MB. Screening for refractive error and fitting with spectacles in rural and urban India: Cost-effectiveness. Ophthalmic Epidemiology 2009;16(6):378-387.
62. Furse Aa, Cleghorn, W.b , Andrysek, J.a c Development of a low-technology prosthetic swing-phase mechanism. Journal of Medical and Biological Engineering 2011;31(2):145-150.
63. Furse Aab, Cleghorn, W.c , Andrysek, J.a d Improving the gait performance of nonfluid-based swing-phase control mechanisms in transfemoral prostheses. IEEE Transactions on Biomedical Engineering 2011;58(8):2352-2359.
64. Gao J, Yang Y, Liang C, Wang X, Wu Z, Yang L. The application of speech testing in choosing hearing aids. Chinese Journal of Clinical Rehabilitation 2003;7(7):1122-1123.
65. Gao JL, Yong YZ, Wu ZM, Wang XY, Feng YP, Yang L. Application of speech audiometry in hearing aid selection. Chinese Journal of Clinical Rehabilitation 2006;10(45):206-207.
66. Gcaza S, Lorenzo T. Discovering the barriers that stop children with disabilities from being children: the impact of lack of access to mobility devices -- a human rights perspective. South African Journal of Occupational Therapy 2008;38(1):16-21.
67. Ghoseiri K, Bahramian H. User satisfaction with orthotic and prosthetic devices and services of a single clinic. Disability & Rehabilitation 2012;34(15):1328-1332.

68. Glumac LK, Pennington SL, Sweeney JK, Leavitt RL. Guatemalan caregivers' perceptions of receiving and using wheelchairs donated for their children. Pediatric Physical Therapy 2009;21(2):167-175.
69. Glykas M, Chytas P. Technology assisted speech and language therapy. International Journal of Medical Informatics 2004;73(6):529-541.
70. Gnyawali S, Shrestha JB, Bhattarai D, Upadhyay M. Optical needs of students with low vision in integrated schools of Nepal. Optometry and vision science: official publication of the American Academy of Optometry 2012;89(12):1752-1756.
71. Gogate P, Soneji F, Kharat J, Dulera H, Deshpande M, Gilbert C. Ocular disorders in children with learning disabilities in special education schools of Pune, India. Indian Journal of Ophthalmology 2011;59(3):223-228.
72. Goins RT, Spencer SM, Goli S, Rogers JC. Assistive technology use of older American Indians in a southeastern tribe: the native elder care study. Journal of the American Geriatrics Society 2010;58(11):2185-2190.
73. Gonzalez-Meijome JM, Jorge J, Almeida JB, Parafita MA. Contact lens fitting profile in Portugal in 2005: Strategies for first fits and refits. Eye and Contact Lens 2007;33(2):81-88.
74. Gopal R, Hugo SR, Louw B. Identification and follow-up of children with hearing loss in Mauritius. International Journal of Pediatric Otorhinolaryngology 2001;57(2):99-113.
75. Gothwal VK, Herse P. Characteristics of a paediatric low vision population in a private eye hospital in India. Ophthalmic and Physiological Optics 2000;20(3):212-219.
76. Guimaraes E, Mann WC. Evaluation of pressure and durability of a low-cost wheelchair cushion designed for developing countries. International Journal of Rehabilitation Research 2003;26(2):141-143.
77. Gunawardena NS, Seneviratne RA, Athauda T. Prosthetic outcome of unilateral lower limb amputee soldiers in two districts of Sri Lanka. Journal of Prosthetics & Orthotics (JPO) 2004;16(4):123-129.
78. Hamdi N, Dweiri Y, Al-Abdallat Y, Haneya T. A practical and feasible control system for bifunctional myoelectric hand prostheses. Prosthetics and Orthotics International 2010;34(2):195-205.
79. Hamzat TK, Kobiri A. Effects of walking with a cane on balance and social participation among community-dwelling post -stroke individuals. European Journal of Physical and Rehabilitation Medicine 2008;44(2):121-126.
80. Hansen A, Meier M, Sam M, Childress D, Edwards M. Alignment of trans–tibial prostheses based on roll–over shape principles. Prosthetics and Orthotics International 2003;27(2):89-99.
81. Harkins CSa, McGarry, A.a , Buis, A.b Provision of prosthetic and orthotic services in low-income countries: A review of the literature. Prosthetics and Orthotics International 2013;37(5):353-361.
82. He M, Abdou A, Ellwein LB, Naidoo KS, Sapkota YD, Thulasiraj RD, Varma R, Zhao J, Kocur I, Congdon NG. Age-related Prevalence and Met Need for Correctable and Uncorrectable Near Vision Impairment in a Multi-country Study. Ophthalmology 2013.
83. He M, Abdou A, Naidoo KS, Sapkota YD, Thulasiraj RD, Varma R, Zhao J, Ellwein LB. Prevalence and correction of near vision impairment at seven sites in China, India, Nepal, Niger, South Africa, and the United States. American Journal of Ophthalmology 2012;154(1):107-116.
84. He M, Xu J, Yin Q, Ellwein LB. Need and challenges of refractive correction in urban Chinese school children. Optometry and Vision Science 2005;82(4):229-234.
85. Hemraj S, James SJ. Age of suspicion and diagnosis of hearing impairment in children attending special schools. Australasian Medical Journal 2012;5(1):43-44.
86. Herrera-Saray P, Pelaez-Ballestas I, Ramos-Lira L, Sanchez-Monroy D, Burgos-Vargas R. Usage problems and social barriers faced by persons with a wheelchair and other aids. Qualitative study from the ergonomics perspective in persons disabled by rheumatoid arthritis and other conditions. Reumatologia Clinica 2013;9(1):24-30.

87. Holden BA, Fricke TR, Ho SM, Wong R, Schlenther G, Cronje S, Burnett A, Papas E, Naidoo KS, Frick KD. Global vision impairment due to uncorrected presbyopia. Archives of Ophthalmology 2008;126(12):1731-1739.
88. Hornby SJ, Adolph S, Gothwal VK, Gilbert CE, Dandona L, Foster A. Requirements for optical services in children with microphthalmos, coloboma and microcornea in Southern India. Eye 2000;14(2):219-224.
89. Hussain S. Toes that look like toes: Cambodian children's perspectives on prosthetic legs. Qualitative health research 2011;21(10):1427-1440.
90. Ikeda AJ, A MG, Lindsley A, Sadeghi-Demneh E, Reisinger KD. A scoping literature review of the provision of orthoses and prostheses in resource-limited environments 2000-2010. Part one: considerations for success. Prosthetics and Orthotics International 2013.
91. Ikeda AJ, Grabowski AM, Lindsley A, Sadeghi-Demneh E, Reisinger KD. A scoping literature review of the provision of orthoses and prostheses in resource-limited environments 2000-2010. Part two: research and outcomes. Prosthetics and Orthotics International 2013.
92. Israsena P, Isaradisaikul S, Noymai A, Boonyanukul S, Hemakom A, Chinnarat C, Navacharoen N, Lekagul S. Developing an appropriate digital hearing aid for low-resource countries: A case study. The Scientific World Journal 2013;2013.
93. Jafari Z, Malayeri S, Ashayeri H. The ages of suspicion, diagnosis, amplification, and intervention in deaf children. Int J Pediatr Otorhinolaryngol 2007;71(1):35-40.
94. Jefferds AN, Beyene NM, Upadhyay N, Shoker P, Pearlman JL, Cooper RA, Wee J. Current state of mobility technology provision in less-resourced countries. Phys Med Rehabil Clin N Am 2010;21(1):221-42.
95. Jefferds AN, Pearlman JL, Wee J, Cooper RA. International mobility technology research: a Delphi study to identify challenges and compensatory strategies. Assistive Technology 2011;23(4):232-242.
96. Jensen JS, Craig JG, Mtalo LB, Zelaya CM. Clinical field follow-up of high density polyethylene (HDPE)-Jaipur prosthetic technology for trans-tibial amputees. Prosthetics and Orthotics International 2004;28(3):230-244.
97. Jensen JS, Craig JG, Mtalo LB, Zelaya CM. Clinical field follow-up of high density polyethylene (HDPE)-Jaipur prosthetic technology for trans-femoral amputees. Prosthetics and Orthotics International 2004;28(2):152-166.
98. Jensen JS, Nilsen R, Thanh NH, Saldana A, Hartz C. Clinical field testing of polyurethane feet for trans-tibial amputees in tropical low-income countries. Prosthetics and Orthotics International 2006;30(2):182-194.
99. Jensen JS, Nilsen R, Zeffer J. Quality benchmark for trans-tibial prostheses in low-income countries. Prosthetics and Orthotics International 2005;29(1):53-58.
100. Jensen JS, Nilsen R, Zeffer J, Fisk J, Hartz C. Clinical field testing of vulcanized rubber feet for trans-tibial amputees in tropical low-income countries. Prosthetics and Orthotics International 2006;30(2):195-212.
101. Jensen JS, Poetsma PA, Thanh NH. Sand-casting technique for trans-tibial prostheses. . Prosthetics and Orthotics International 2005;29(2):165-175.
102. Jensen JS, Raab W. Clinical field testing of trans-femoral prosthetic technologies: Resin-wood and ICRC-polypropylene. Prosthetics and Orthotics International 2004;28(2):141-151.
103. Jensen JS, Raab W. Clinical field-testing of ATLAS prosthetic system for trans-tibial amputees. Prosthetics and Orthotics International 2002;26(2):86-92.
104. Jensen JS, Raab W. Clinical field testing of vulcanized Jaipur rubber feet for trans-tibial amputees in low-income countries. Prosthetics and Orthotics International 2006;30(3):225-236.
105. Jensen JS, Raab W. Clinical field testing of vulcanized Jaipur rubber feet for trans-tibial amputees in low-income countries. . Prosthetics and Orthotics International 2007;31(1):105-115.

106. Jensen JS, Raab W, Fisk J, Hartz C, Saldana A, Harte C. Quality of polypropylene sockets for trans-tibial prostheses in low-income countries. Prosthetics and Orthotics International 2006;30(1):45-59.
107. Jensen JS, Treichl HB. Mechanical testing of prosthetic feet utilized in low-income countries according to ISO-10328 standard. Prosthetics and Orthotics International 2007;31(2):177-206.
108. Jiang CS, Zheng SZ, Yuan F, Jia HJ, Zhan ZN, Wang JJ. Experimental assessment on the moving capabilities of mobility-impaired disabled. Safety Science 2012;50(4):974-985.
109. Jones A, Silva PG, Silva AC, Colucci M, et al. Impact of cane use on pain, function, general health and energy expenditure during gait in patients with knee osteoarthritis: A randomised controlled trial. Annals of the Rheumatic Diseases 2012;71(2):172-179.
110. Joseph P. A study on certain factors influencing language performance of hearing impaired students. Asia Pac Disabil Rehabil 2003;14(2):201-208.
111. Kahveci OK, Miman MC, Okur E, Aycicek A, Sevinc S, Altuntas A. [Hearing aid use and patient satisfaction]. Kulak Burun Bogaz Ihtis Derg 2011;21(3):117-21.
112. Kashyap AS, Kashyap S. Increased prevalence of impaired hearing in patients with type 2 diabetes in western India. Postgraduate Medical Journal 2000;76(891):38.
113. Keay L, Gandhi M, Brady C, Ali FS, Mathur U, Munoz B, Friedman DS. A randomized clinical trial to evaluate ready-made spectacles in an adult population in India. International Journal of Epidemiology 2010;39(3):877-888.
114. Keay L, Zeng Y, Munoz B, He M, Friedman DS. Predictors of early acceptance of free spectacles provided to junior high school students in China. Archives of Ophthalmology 2010;128(10):1328-1334.
115. Khan SA, Das T, Kumar SM, Nutheti R. Low vision rehabilitation in patients with age-related macular degeneration at a tertiary eye care centre in southern India. Clinical and Experimental Ophthalmology 2002;30(6):404-410.
116. Kheng S. The challenges of upgrading from ISPO Category II level to Bachelor Degree level by distance education. Prosthetics and Orthotics International 2008;32(3):299-312.
117. Kirby RL, Cooper RA. Applicability of the Wheelchair Skills Program to the Indian context. Disability & Rehabilitation 2007;29(11-12):969-972.
118. Kpadonou GT, Alagnide E, Kpadonou-Fiossi EA, Houngbedji G, Azanmasso H, Niama ND. Orthopaedic artificial limb for Child in Cotonou: What specicity in the phase o polio eradication. Annals of Physical and Rehabilitation Medicine 2013;56:e33-e34.
119. Krenek SM, Vasquez M. A case report on the collaboration of health care professionals in fitting and training seven Iraqi clients with right wrist disarticulations 9 years postamputation. American Journal of Occupational Therapy 2006;60(3):340-347.
120. Laki T. Use of AT in sheltered homes for persons with cognitive disabilities in hungary - Conclusions of a survey. Technology and Disability 2002;14(4):157-161.
121. Lamberg EM, Collins CK, Hanks JE, Alaniz MB. Management of proximal femoral focal deficiency with limited resources in Haiti. Prosthetics and Orthotics International 2013;37(1):58-64.
122. Laviers H, Burhan I, Omar F, Jecha H, Gilbert C. Evaluation of distribution of presbyopic correction through primary healthcare centres in Zanzibar, East Africa. British Journal of Ophthalmology 2011;95(6):783-787.
123. Laviers HR, Omar F, Jecha H, Kassim G, Gilbert C. Presbyopic spectacle coverage, willingness to pay for near correction, and the impact of correcting uncorrected presbyopia in adults in Zanzibar, East Africa. Investigative Ophthalmology and Visual Science 2010;51(2):1234-1241.
124. Leake FS, Thompson JW, Simms E, Bailey J, Stocks RMS, Murphy AM. Acquisition of hearing aids and assistive listening devices among the pediatric hearing-impaired population. International Journal of Pediatric Otorhinolaryngology 2000;52(3):247-251.
125. Lemaire ED, Fawcett J, Nielen D, Leung AKL. Telehealth strategies for remote prosthetic applications. Technology and Disability 2003;15(2):145-150.

126. Li L, Lam J, Lu Y, Ye Y, Lam DSC, Gao Y, Sharma A, Zhang M, Griffiths S, Congdon N. Attitudes of students, parents, and teachers toward glasses use in rural China. Archives of Ophthalmology 2010;128(6):759-765.
127. Li L, Song Y, Liu X, Lu B, Choi K, Lam DS, Zhang M, Zheng M, Wang Y, Sharma A and others. Spectacle acceptance among secondary school students in rural China: the Xichang Pediatric Refractive Error Study (X-PRES)--report 5. Invest Ophthalmol Vis Sci 2008;49(7):2895-902.
128. Li Z, Ajuwon PM, Smith DW, Griffin-Shirley N, Parker AT, Okungu P. Assistive Technology Competencies for Teachers of Students with Visual Impairments: A National Study. Journal of Visual Impairment & Blindness 2012;106(10):656-665.
129. Liu XH. Application of lower limb orthosis in paralysis rehabilitation. Journal of Clinical Rehabilitative Tissue Engineering Research 2007;11(31):6252-6255.
130. Madriz JJ. Audiology in Latin America: Hearing impairment, resources and services. Scandinavian Audiology, Supplement 2001;30(53):85-92.
131. Magnusson L, Ahlström G. Experiences of providing prosthetic and orthotic services in Sierra Leone - the local staff's perspective. Disability & Rehabilitation 2012;34(24):2111-2118.
132. Magnusson L, Ahlstrom G, Ramstrand N, Fransson EI. Malawian prosthetic and orthotic users' mobility and satisfaction with their lower limb assistive device. Journal of rehabilitation medicine: official journal of the UEMS European Board of Physical and Rehabilitation Medicine 2013;45(4):385-391.
133. Magnusson L, Ramstrand N. Prosthetist/orthotist educational experience & professional development in Pakistan. Disabil Rehabil Assist Technol 2009;4(6):385-92.
134. Maharjan M, Tharu P. Global health-a project to reach the unreached through community ear services for the prevention and treatment of deafness in Nepal. Clinical Otolaryngology 2012; 37:138.
135. Mann WC, De Mello MAF. Assistive technology use by the elderly in Brazil and the United States. Topics in Geriatric Rehabilitation 2010;26(1):62-69.
136. Marinho Cezar D, Luisa. Associations among occupational roles, independence, assistive technology, and purchasing power of individuals with physical disabilities<sup>1</sup? Revista Latino-Americana de Enfermagem (RLAE) 2013;21(2):484-491.
137. Marmamula S, Keeffe JE, Rao GN. Uncorrected refractive errors, presbyopia and spectacle coverage: Results from a rapid assessment of refractive error survey. Ophthalmic Epidemiology 2009;16(5):269-274.
138. Marmamula S, Madala SR, Rao GN. Prevalence of uncorrected refractive errors, presbyopia and spectacle coverage in marine fishing communities in South India: Rapid Assessment of Visual Impairment (RAVI) project. Ophthalmic & physiological optics: the journal of the British College of Ophthalmic Opticians (Optometrists) 2012;32(2):149-155.
139. Marmamula S, Ravuri LVCS, Boon MY, Khanna RC. Spectacle coverage and spectacles use among elderly population in residential care in the south Indian state of Andhra Pradesh. BioMed Research International 2013;2013.
140. McAdam JC, Casteleijn D. The factors impacting on the utilisation and condition of wheelchairs in a developing community. South African Journal of Occupational Therapy 2005;35(2):2-7.
141. McCahill J, Stebbins J, Bates J, Batchelor A, Church J, Lavy C. The African Disability Scooter: Preliminary analysis of a new mobility aid. Disability and Rehabilitation: Assistive Technology 2009;4(5):353-356.
142. McCambridge M. Coordinating Wheelchair Provision in Developing Countries. In: Proceedings of the RESNA 2000 Annual Conference: Technology for the New Millennium, Orlando, Florida, 28 June – 2 July 2000. Atlanta, GA, RESNA, 2000:234–236.
143. McCarthy T, Pal J, Cutrell E. The “Voice” Has It: Screen Reader Adoption and Switching Behavior Among Vision Impaired Persons in India. Assistive Technology 2013;25(4):222-229.
144. Meier MR, Sam M, Hansen AH, Childress DS. The 'shape&roll' prosthetic foot: II. Field testing in El Salvador. Medicine, conflict, and survival 2004;20(4):307-325.

145. Mejia-Rosas F, Paz-Romero M, Rolon-Lacarriere OG, Bermudez-Jimenez JA. Volitional level attendance at stake through technology in patients with cerebral palsy, type spastic quadriparesis of moderate degree. Revista Mexicana de Neurociencia 2010;11(6):451-456.
146. Metring NL, Gaspar MIFAS, Mateus-Vasconcelos ECL, Gomes MM, De Abreu DCC. Influence of different types of seat cushions on the static sitting posture in individuals with spinal cord injury. Spinal Cord 2012;50(8):627-631.
147. Mohd Adibi SMAB, Ru Chen N, Aida Azmir N, Solahan N, Ismail A, Zainal Anuar A, Binti Abdullah A. The quality of life in hearing impaired adolescents after hearing aid application. Medical Journal of Malaysia 2013;68(4):315-322.
148. Moreno D, Ramirez-Garcia A, Leija L, Munoz R, Vera A, Toledo C. Using 'stall detection' as an auxiliary mechanism for sensing obstacles and hand grasping in arm prosthesis. Conference proceedings: Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Conference 2010; 2010:507-510.
149. Morgan PB, Efron N, Woods CA. An international survey of contact lens prescribing for presbyopia. Clinical and Experimental Optometry 2011;94(1):87-92.
150. Morgan PB, Efron N, Woods CA. An international survey of toric contact lens prescribing. Eye and Contact Lens 2013;39(2):132-137.
151. Mosuro AL, Ajaiyeoba AI, Bekibele CO, Eniola MS, Adedokun BA. Survey of low vision among students attending schools for the blind in Nigeria: A descriptive and interventional study. Middle East African Journal of Ophthalmology 2012;19(4):382-391.
152. Mukherjee G, Samanta A. Evaluation of ambulatory performance of the arm propelled three-wheeled chair using heart rate as a control index. Disabil Rehabil 2000;22(10):464-70.
153. Mukherjee G, Samanta A. Physiological response to the ambulatory performance of hand-rim and arm-crank propulsion systems. J Rehabil Res Dev 2001;38(4):391-399.
154. Mukherjee G, Samanta A. Arm-crank propelled three-wheeled chair: physiological evaluation of the propulsion using one arm and both arm patterns. International Journal of Rehabilitation Research 2004;27(4):321-324.
155. Mukherjee G, Samanta A. Wheelchair charity: a useless benevolence in community-based rehabilitation. Disabil Rehabil 2005;27(10):591-6.
156. Mulholland SJ, Packer TL, Laschinger SJ, Lysack JT, Wyss UP, Balaram S. Evaluating a new mobility device: Feedback from women with disabilities in India. Disability and Rehabilitation 2000;22(3):111-122.
157. Nigam R. Sociocultural development and validation of lexicon for Asian-Indian individuals who use augmentative and alternative communication. Disability and rehabilitation. Assistive technology 2006;1(4):245-256.
158. Norton KJ. Navajo-ABLE: Replication Model Navajo Assistive Technology Loan Program - Final Program Evaluation. Santa Fe, NM: New Mexico State Dept. of Education, Santa Fe; 2002 2002.
159. Ntim-Amponsah CT, Amoaku WMK. Causes of childhood visual impairment and unmet low-vision care in blind school students in Ghana. International Ophthalmology 2008;28(5):317-323.
160. Nwadinigwe CU, Anyaehie UE, Onyegbule EC. The impact of water mattresses on incidence of PUs in patients with spinal cord injuries in Nigeria. Journal of Wound Care 2012;21(4):184-189.
161. Odedra N, Wedner SH, Shigongo ZS, Nyalali K, Gilbert C. Barriers to spectacle use in Tanzanian secondary school students. Ophthalmic Epidemiol 2008;15(6):410-7.
162. Olusanya B. Self-reported outcomes of aural rehabilitation in a developing country. International Journal of Audiology 2004;43(10):563-571.
163. Omar R, Mohammed Z, Knight VF, Basrul MH. Profile of low vision children in the special education schools in Malaysia. Medical Journal of Malaysia 2009;64(4):289-293.
164. Ooi AL, Julia PE. The use of unconventional pressure redistributing cushion in spinal cord injured individuals. Spinal Cord 2011;49(12):1203-5.

165. Owens J, Simonds C. Beyond the wheelchair: Development of motorised transport for people with severe mobility impairments in developing countries. Disability and Rehabilitation: Assistive Technology 2010;5(4):254-257.
166. Öztürk A, Ucsular FD. Effectiveness of a wheelchair skills training programme for community-living users of manual wheelchairs in Turkey: a randomized controlled trial. Clinical rehabilitation 2011;25(5):416-424.
167. Pal N, Titiyal JS, Tandon R, Vajpayee RB, Gupta S, Murthy GV. Need for optical and low vision services for children in schools for the blind in North India. Indian J Ophthalmol 2006;54(3):189-93.
168. Parving A, Christensen B. Clinical trial of a low-cost, solar-powered hearing aid. Acta Oto-Laryngologica 2004;124(4):416-420.
169. Patel I, Munoz B, Mkocha H, Schwarzwalder AW, McHiwa W, West SK. Change in function and spectacle-use 2 months after providing presbyopic spectacles in rural Tanzania. Br J Ophthalmol 2010;94(6):685-9.
170. Pearce MG, Pearce N. Addressing refractive error visual impairment: Volunteer organisations' alignment with Vision 2020 and public health principles. Clinical and Experimental Optometry 2012;95(6):583-589.
171. Pearlman J, Cooper R, Chhabra HS, Jefferds A. Design, development and testing of a low-cost electric powered wheelchair for India. Disability and rehabilitation. Assistive technology 2009;4(1):42-57.
172. Pearlman J, Cooper RA, Krizack M, Lindsley A, Wu Y, Reisinger KD, Armstrong W, Casanova H, Chhabra HS, Noon J. Lower-limb prostheses and wheelchairs in low-income countries. IEEE Eng Med Biol Mag 2008;27(2):12-22.
173. Pearlman J, Cooper RA, Zipfel E, Cooper R, McCartney M. Towards the development of an effective technology transfer model of wheelchairs to developing countries. Disabil Rehabil Assist Technol 2006;1(1-2):103-10.
174. Pearlman J, Jefferds A, Nagi I, Chhabra HS, Cooper R. Designing Assistive Technology For Less-Resourced Environments: An Online Method to Gauge Accessibility Barriers and Collect Design Advice. 2007 2007. RESNA Press.
175. Pienaar E, Stearn N, Swanepoel W. Self-reported outcomes of aural rehabilitation for adult hearing aid users in a South African context. The South African journal of communication disorders. Die Suid-Afrikaanse tydskrif vir Kommunikasieafwykings 2010; 57:4, 6, 8 passim.
176. Raizada K, Sridhar MS. Nomogram for spherical rgp contact lens fitting in patients with pellucid marginal corneal degeneration (PMCD). Eye and Contact Lens 2003;29(3):168-172.
177. Raja K. Compliance with walking aid use in children with cerebral palsy in India. American Journal of Physical Medicine and Rehabilitation 2006;85(8):694-698.
178. Ramasamy D, Joseph S, Valaguru V, Mitta VP, Ravilla TD, Cotch MF. Cluster randomized trial to compare spectacle delivery systems at outreach eye camps in South India. Ophthalmic Epidemiology 2013;20(5):308-314.
179. Ramke J, Brian G. Are readymade spectacles sufficient in developing countries? Clin Experiment Ophthalmol 2009;37(9):900-2.
180. Ramke J, Brian G, Naduvilath T. Refractive error and presbyopia in Timor-Leste: The impact of 5 years of a national spectacle program. Investigative Ophthalmology and Visual Science 2012;53(1):434-439.
181. Ramke J, Brian G, Palagyi A. Spectacle dispensing in Timor-Leste: Tiered-pricing, cross-subsidization and financial viability. Ophthalmic Epidemiology 2012;19(4):231-235.
182. Ramke J, Du Toit R, Brian G. An assessment of recycled spectacles donated to a developing country. Clinical and Experimental Ophthalmology 2006;34(7):671-676.
183. Ramke J, Du Toit R, Palagyi A, Brian G, Naduvilath T. Correction of refractive error and presbyopia in Timor-Leste. British Journal of Ophthalmology 2007;91(7):860-866.

184. Ramke J, du Toit R, Palagyi A, Williams C, Brian G. Public sector refraction and spectacle dispensing in low-resource countries of the Western Pacific. Clin Experiment Ophthalmol 2008;36(4):339-47.
185. Ramke J, Palagyi A, Du Toit R, Brian G. Using assessment of willingness to pay to improve a Cambodian spectacle service. British Journal of Ophthalmology 2008;92(2):170-174.
186. Ramke J, Palagyi A, Du Toit R, Brian G. Stated and actual willingness to pay for spectacles in Timor-Leste. Ophthalmic Epidemiology 2009;16(4):224-230.
187. Ramke J, Palagyi A, Toit R, Brian G. Applying standards to readymade spectacles used in low-resource countries. Optom Vis Sci 2009;86(9):1104-11.
188. Reisinger KD, Casanova H, Wu Y, Moorer C. Comparison of á priori alignment techniques for transtibial prostheses in the developing world -- pilot study. Disability & Rehabilitation 2007;29(11-12):863-872.
189. Reisinger KD, Casanova H, Wu Y, Moorer C. Evaluation and comparison of á priori alignment techniques for transtibial prostheses in the developing world - field trial in Nicaragua. Disability & Rehabilitation: Assistive Technology 2009;4(6):393-405.
190. Rewri P, Kakkar M, Raghav D. Self-vision testing and intervention seeking behavior among school children: A pilot study. Ophthalmic Epidemiology 2013;20(5):315-320.
191. Rob B, Vinod J A, Monica P, Balraj A, Job A, Norman G, Joseph A. Costs and health effects of screening and delivery of hearing aids in Tamil Nadu, India: An observational study. BMC public health 2009;9.
192. Saensook W, Phonthee S, Srisim K, Mato L, Wattanapan P, Amatachaya S. Ambulatory assistive devices and walking performance in patients with incomplete spinal cord injury. Spinal Cord 2013.
193. Sam M, Childress DS, Hansen AH, Meier MR, Lambla S, Grahn EC, Rolock JS. The 'shape&roll' prosthetic foot: I. Design and development of appropriate technology for low-income countries. Medicine, conflict, and survival 2004;20(4):294-306.
194. Sam M, Hansen AH, Childress DS. Characterisation of prosthetic feet used in low-income countries. Prosthetics and Orthotics International 2004;28(2):132-140.
195. Sanker N, Noushad B. Trend of soft contact lens prescribing in an optometry centre in India: A 6-year analysis. Contact Lens and Anterior Eye 2013;36(4):196-198.
196. Sathishkumar S, Manigandan C, Asha T, Charles J, Pradeep Poonoose P. A cost-effective, adjustable, femoral socket, temporary prosthesis for immediate rehabilitation of above-knee amputation. International Journal of Rehabilitation Research 2004;27(1):71-74.
197. Serpentine EC, Tarnai B, Drager KDR, Finke EH. Decision making of parents of children with autism spectrum disorder concerning augmentative and alternative communication in Hungary. Communication Disorders Quarterly 2011;32(4):221-231.
198. Shah M, Zaman M, Khan MT, Khan MD. Visual rehabilitation of patients with Stargardt's disease. Journal of the College of Physicians and Surgeons Pakistan 2008;18(5):294-298.
199. Shah SP, Jadoon MZ, Dineen B, Bourne RRA, Johnson GJ, Gilbert CE, Khan MD. Refractive errors in the adult Pakistani population: The national blindness and visual impairment survey. Ophthalmic Epidemiology 2008;15(3):183-190.
200. Shandiz MAab, Farahmand, F.a b , Osman, N.A.A.c , Zohoor, H.a A robotic model of transfemoral amputee locomotion for design optimization of knee controllers. International Journal of Advanced Robotic Systems 2013;10(art. no. 161).
201. Shane TS, Knight O, Shi W, Schiffman JC, Alfonso EC, Lee RK. Treating uncorrected refractive error in adults in the developing world with autorefractors and ready-made spectacles. Clinical and Experimental Ophthalmology 2011;39(8):729-733.
202. Sharma A, Congdon N, Patel M, Gilbert C. School-based Approaches to the Correction of Refractive Error in Children. Survey of Ophthalmology 2012;57(3):272-283.
203. Sharma MK, Thapa H, Paudyal B, Adhikari RK, Dhakwa K. A profile of low vision among the blind school students in Lumbini Zone of Nepal. Nepalese journal of ophthalmology: a biannual peer-reviewed academic journal of the Nepal Ophthalmic Society: NEPJOPH 2010;2(2):127-131.

204. Sherwin JC, Keeffe JE, Kuper H, Islam FMA, Muller A, Mathenge W. Functional presbyopia in a rural Kenyan population: The unmet presbyopic need. Clinical and Experimental Ophthalmology 2008;36(3):245-251.
205. Shida-Tokeshi J, Bagley A, Molitor F, Tomhave W, Liberatore J, Brasington K, Montpetit K. Predictors of continued prosthetic wear in children with upper extremity prostheses. Journal of Prosthetics & Orthotics (JPO) 2005;17(4):119-124.
206. Shore S, Juillerat S. The impact of a low cost wheelchair on the quality of life of the disabled in the developing world. Medical Science Monitor 2012;18(9):CR533-CR542.
207. Shore SL. Use of an economical wheelchair in India and Peru: impact on health and function. Med Sci Monit 2008;14(12):PH71 -9.
208. Sia DIT, Muecke J, Hammerton M, Ngy M, Kong A, Morse A, Holmes M, Piseth H, Hamilton C, Selva D. A survey of visual impairment and blindness in children attending four schools for the blind in Cambodia. Ophthalmic Epidemiology 2010;17(4):225-233.
209. Sitek A. Design of a Low-Cost Prosthesis for Use in Developing Regions. 2003 2003. RESNA Press.
210. Smith AC, Krause C. Providing disabled persons in developing countries access to computer games through a novel gaming input device. International Journal on Disability and Human Development 2011;10(1):59-62.
211. Soares MM, Jacobs K, Barros HO, Soares MM. Using digital photogrammetry to conduct an anthropometric analysis of wheelchair users. Work 2012; 41:4053-4060.
212. Soares MM, Jacobs K, Lucero-Duarte K, Enrique, López-Millán F, Soto-Félix S. Anthropometric data of adult wheelchair users for Mexican population. Work 2012; 41:5408-5410.
213. Srinivasan S, Mathew SN, Lloyd LL. Insights into communication intervention and AAC in South India: A mixed-methods study. Communication Disorders Quarterly 2011;32(4):232-246.
214. Strauss S, Van Dijk C. Hearing instrument fittings of pre-school children: Do we meet the prescription goals? International Journal of Audiology 2008;47(SUPPL. 1): S62-S71.
215. Suzuki T, Sonoda S, Saitoh E, Murata M, Uno A, Shimizu Y, Misawa K, Kotake T. Development of a novel type of shoe to improve the efficiency of knee-ankle-foot orthoses with a medial single hip joint (Primewalk orthoses): A novel type of shoe for Primewalk orthosis. Prosthetics and Orthotics International 2005;29(3):303-311.
216. Sweeney DF, Terry RL, Covey MA, Sankaridurg PR, Holden BA, Rao GN. The ocular response of wearers of daily disposable and extended wear soft contact lenses compared to spectacle wearers. Practical Optometry 2001;12(3):84-88.
217. Takara K, Gaspar MIFAS, Metring NL, Mateus-Vasconcelos ECL, Cliquet Jr A, Abreu DCC. Evaluation of the influence of different types of seats on postural control in individuals with paraplegia. Spinal Cord 2010;48(11):825-827.
218. Tatar Y. Body image and its relationship with exercise and sports in Turkish lower-limb amputees who use prosthesis. Science & Sports 2010;25(6):312-317.
219. Thanh N, Poetsma P, Jensen J. Preliminary experiences with the CIR casting system for transtibial prosthetic sockets. . Prosthetics and Orthotics International 2009;33(2):130-134.
220. Thite N, Noushad B, Kunjeer G. Contact lens prescribing pattern in India-2011. Contact Lens and Anterior Eye 2013;36(4):182-185.
221. Toit RD, Ramke J, Brian G. Tolerance to prism induced by readymade spectacles: Setting and using a standard. Optometry and Vision Science 2007;84(11):1053-1059.
222. Toit RD, Ramke J, Palagyi A, Brian G. Spectacles in Fiji: Need, acquisition, use and willingness to pay. Clinical and Experimental Optometry 2008;91(6):538-544.
223. Toro MLac, Garcia, Y.a c , Ojeda, A.M.a c , Dausey, D.J.b , Pearlman, J.a c Quantitative exploratory evaluation of the frequency, causes and consequences of rehabilitation wheelchair breakdowns delivered at a paediatric clinic in Mexico. Asia Pacific Disability Rehabilitation Journal 2012;23(3):48-64.

224. Toscano DA, Florencio ACT, da Conceicao Sales M, Cavalcanti MT, Antunes DAL. Pediatric contact lens users in public and private services: comparative analysis. Arquivos Brasileiros de Oftalmologia 2009;72(2):221-224.
225. Treacy MP, Treacy MG, Dimitrov BD, Seager FE, Stamp MA, Murphy CC. A method for the prescription of inexpensive spectacles by non-specialist healthcare workers: S-Glasses. Eye (Basingstoke) 2013;27(4):474-479.
226. Uribe JA, Swenor BK, Munoz BE, West SK. Uncorrected refractive error in a latino population: Proyecto VER. Ophthalmology 2011;118(5):805-811.
227. van Brakel WH, Poetsma PA, Tam PT, Verhoeff T. User satisfaction and use of prostheses in ICRC's Special Fund for the Disabled project in Vietnam. Asia Pacific Disability Rehabilitation Journal 2010;21(2):70-91.
228. van der Merwe E, Alant E. Associations with Minspeak icons. J Commun Disord 2004;37(3):255-74.
229. Vecchiotti RG, Allyn KJ, Buell NC, Hafner BJ, Reisinger KD, Weber EL, Smith DG. Comparison of Standing versus Supine Alignment Capture Methods for Monolimb Fabrication. 2004 2004/08/01/6.
230. Vicneas WV, Lee FS, Sangetavani M, Chu AR, Thillainathan K, Norhayaty S, Mohd Shahril A, Sararaks S, Mohamad Zaidan Z, Maizatul Azwa MH and others. Walking aids - What do we have in MOH hospitals? Medical Journal of Malaysia 2010; 65:72.
231. Vincent JE. Simple spectacles for adult refugees on the Thailand-Burma border. Optometry and Vision Science 2006;83(11):803-810.
232. Vincent JE, Netek S, Parry A, Mladenovich D, Thein NN, Amendola PR. Reported wearing compliance of ready-made spectacles at 6 and 12 months. Optometry and vision science: official publication of the American Academy of Optometry 2010;87(12):958-965.
233. Visagie S, Scheffler, E. , & Schneider M. Policy implementation in wheelchair service delivery in a rural South African setting. African Journal of Disability 2013; Vol 2(No 1).
234. Waldera KEa, Heckathorne, C.W.a , Parker, M.b , Fatone, S.a Assessing the prosthetic needs of farmers and ranchers with amputations. Disability and Rehabilitation: Assistive Technology 2013;8(3):204-212.
235. Wallace JF, Hayes M, Bailey MN. Assistive technology loan financing: A status of program impact and consumer satisfaction. Technology and Disability 2000;13(1):17-22.
236. Wedner S, Masanja H, Bowman R, Todd J, Gilbert C. Two strategies for correcting refractive errors in school students in Tanzania: Randomised comparison, with implications for screening programmes. British Journal of Ophthalmology 2008;92(1):19-24.
237. Wee J, Rispin K. Comparing real-world utility and clinical complications of two different low-cost pediatric wheelchairs. Archives of Physical Medicine and Rehabilitation 2012;93(10): E56.
238. Welage N, Liu KP. Wheelchair accessibility of public buildings: a review of the literature. Disabil Rehabil Assist Technol 2011;6(1):1-9.
239. Wilson DA, Cronje S, Frick K, Holden BA. Real cost of recycled spectacles. Optometry and vision science: official publication of the American Academy of Optometry 2012;89(3):304-309.
240. Winters JE, Pihos AM. Sight for seniors: A summary of findings and challenges to providing community-based eye care to low-income seniors. Optometry 2008;79(12):718-723.
241. Wormnæs S, Malek YA. Egyptian speech therapists want more knowledge about augmentative and alternative communication. AAC: Augmentative & Alternative Communication 2004;20(1):30-41.
242. Wu Y, Casanova HR, Ikeda AJ. Plastic soda bottles: a reusable material for making transradial sockets. Prosthetics and Orthotics International 2009;33(2):100-6.
243. Wu Y, Casanova H, Smith WK, Edwards M, Childress DS. CIR sand casting system for transtibial socket. Prosthetics and Orthotics International 2003;27(2):146-152.
244. Yingyong P. Refractive errors survey in primary school children (6-12 year old) in 2 provinces: Bangkok and Nakhonpathom (one year result). J Med Assoc Thai 2010;93(10):1205-10.

245. Yong R. "VisionTouch phone" for the blind. Malaysian Journal of Medical Sciences 2013;20(5):1-4.
246. Zastrow L. Evaluation Report of the Native American Consortium for Educational and Assistive Technologies for Indian Children Living on the Acoma and Laguna Pueblos. Council for Exceptional Children; 2002 2002.
247. Zeng Y, Keay L, He M, Mai J, Munoz B, Brady C, Friedman DS. A Randomized, Clinical Trial Evaluating Ready-Made and Custom Spectacles Delivered Via a School-Based Screening Program in China. Ophthalmology 2009;116(10):1839-1845.
248. Zhang M, Lv H, Gao Y, Griffiths S, Sharma A, Lam D, Li L, Tse YK, Liu X, Xu D and others. Visual morbidity due to inaccurate spectacles among school children in rural China: The see well to learn well project, Report 1. Investigative Ophthalmology and Visual Science 2009;50(5):2011-2017.
249. Zhang XY. New structure, material, technology in modern prostheses. Chinese Journal of Clinical Rehabilitation 2002;6(20):2989-2991.
250. Zhu JW, Liu F, Dong QR, Xu WW, Bai EZ, Huang X. Computer-assisted design of individualized femoral prosthesis according to 3D reconstruction of CT images. Journal of Clinical Rehabilitative Tissue Engineering Research 2010;14(35):6639-6642.
251. Zhu M, Tong X, Zhao R, He X, Zhao H, Liu M, Zhu J. Visual impairment and spectacle coverage rate in Baoshan district, China: population-based study. BMC public health 2013; 13:311.
252. Zipfel E, Cooper RA, Pearlman J, Cooper R, McCartney M. New design and development of a manual wheelchair for India. Disability & Rehabilitation 2007;29(11-12):949-962.

APPENDIX B: SECONDARY ANALYSIS TABLES (CHAPTER 4)

Table B.1 Description of explanatory variables

Explanatory variables		**Survey items**	**Response options**
Employed or receiving social grant		Are you currently working? (includes casual labourers, part-time work and those who are self-employed).	Recoded: Yes = 1 (respondents who reported that they are 'currently working' or are receiving social security grant, etc.) No = 0 (not working and not receiving grant).
		Are you currently receiving social security, a disability grant or any other form of pension/grant?	
Activity limitation questions:	Seeing	Do you have difficulty seeing, even if wearing glasses?	No difficulty = 0 Some = 1 A lot = 2 Unable = 3 Recoded: Yes = 1 (respondents who had any level of difficulty - Some, A lot, or Unable); No = 0 (No difficulty).
	Hearing	Do you have difficulty hearing, even if using a hearing aid?	
	Walking/ climbing steps	Do you have difficulty walking or climbing steps?	
	Remembering/ concentrating	Do you have difficulty remembering or concentrating?	
	Self-care	Do you have difficulty with self-care such as washing all over or dressing?	
	Communicating	Using your usual (customary) language, do you have difficulty communicating for example understanding or being understood?	
Activity limitations scale (0-18)		Calculated: Numeric responses (0-3) to the six activity limitation questions were added together to form an Activity Limitations Scale. Values ranged from 0 to 18.	
Possession scale (0-26)		Does your household have any of the following? 1) Cell phone 2) Bed(s) 3) Tables & chairs 4) Iron 5) Stove (gas/electric) 6) Electricity 7) TV 8) Radio 9) Refrigerator 10) Satellite dish 11) DVD/VHS 12) Livestock 13) Car 14) Microwave oven 15) Fan 16) Hi-Fi 17) Telephone (land line) 18) Heater 19) Computer	Yes = 1 No = 0

Explanatory variables	Survey items	Response options
	20) Bicycle 21) Stove (paraffin) 22) Washing machine 23) Solar energy 24) Air conditioner 25) Electrical generator 26) Motorcycle	
Dietary diversity scale (0-12)	Now I would like to ask you about the types of foods that you or anyone else in your household prepared and ate in the past TWO weeks during the day and night (food purchased and eaten outside of the home is not included). 1) Cereals 2) Roots and tubes (veg) 3) Leaf vegetables 4) Fruits 5) Meat, poultry, offal 6) Eggs 7) Fish and seafood 8) Pulses/legumes/nuts 9) Milk and milk products 10) Oil/fats 11) Sugar/honey 12) Condiments and any other foods	Yes = 1 No = 0
Access to information scale (0-6)	How available are the following services to your household? 1) Telephone/cell 2) Radio 3) Television 4) Internet 5) Newspaper 6) Library	Yes = 1 (Own/use regularly or Have access to) No = 0 (Have no use for, Have no access to)

Table B.2 Botswana: Bivariate Logistics Regression – Goodness of fit

Model Summary		Hosmer and Lemeshow Test	
-2 Log likelihood	427.767	Chi-square	10.574
Cox & Snell R Square	.237	df	8
Nagelkerke R Square	.318	Sig.	.227

Table B.3 Swaziland: Bivariate Logistics Regression – Goodness of fit

Model Summary		Hosmer and Lemeshow Test	
-2 Log likelihood	265.438	Chi-square	10.614
Cox & Snell R Square	.165	df	8
Nagelkerke R Square	.227	Sig.	.225

APPENDIX C: QUALITATIVE SUB-STUDY CONSENT FORM AND INTERVIEW GUIDE

Consent form

Consent to Participate in Research

What Works to Increase Access to Assistive Technology in Southern Africa: Qualitative Sub-Study

1. WHO IS DOING THIS STUDY AND WHY?

You are being asked to participate in a qualitative research study led by Rebecca Matter, a PhD Candidate from the School of Public Health and Family Medicine at the University of Cape Town. This study is one of three studies that comprise the PhD Dissertation in Public Health entitled What Works to Increase Access to Assistive Technology in Southern Africa.

This qualitative study aims to address the following research questions:

i. What are the facilitator and barriers to assistive technology (AT) access?
ii. How do factors identified interact with each other to increase access to AT?

As part of the study, Rebecca will speak with a diverse range of stakeholders with expertise and experience with the procurement and provision of AT in southern Africa, including:

- Academics engaged in AT research in Southern Africa
- Public, private and civic organizations that procure and provide AT
- AT manufacturers and distributors and suppliers

If you agree to participate in this project, you will be asked to speak with Rebecca Matter in an individual or small group interview between June 2017-January 2018.

2. WHAT WILL YOU DO IN THIS STUDY?

If you volunteer to participate in this study, Rebecca Matter will ask you to answer questions and talk about your relevant AT experiences. If you feel uncomfortable about discussing any AT topics or addressing any interview questions, feel free not to participate or not to answer a particular question. We may ask you for permission to audio record your interview. You will have the choice to have the interview recorded or not. Rebecca Matter will also take notes during the interview. More extensive note taking will be required if the interview is not audio recorded.

3. ARE THERE ANY RISKS IN THIS RESEARCH?

If at any time you do not want to answer a particular question, please tell Rebecca Matter and you will not be asked to answer. You are free to not answer any question or speak about any subject that you do not want to.

4. ARE THERE ANY BENEFITS OF PARTICIPATING FOR ME?

Participants will not be paid or receive any other direct benefits from participating in this study. There may be some longer–term benefits to your organization/business or people with disabilities that you serve if the project is able to contribute to increasing supply of and access to assistive technologies in your region.

Interview Questions

What Works to Increase Access to Assistive Technology in Southern Africa: Qualitative Sub-Study

A. Part I. Participant information

1. Demographics
2. Experience in AT sector in Southern Africa
    a. Countries
    b. Types of AT
    c. Role/sector
    d. Number of years

B. Part II. AT supply and access

Interviewer script: It is well known that AT supply is inadequate in all countries in Southern Africa – simply put: there are not enough devices made locally or imported to address the need. The vast majority of AT is imported from outside of southern Africa and enters countries through a fragmented array of public, for-profit, and non-profit providers. The following question aims to understand why supply is inadequate and identify ways to increase AT access.

A. General
1. What are the primary challenges or bottlenecks to increasing AT supply and access in (insert country/ies with experience/knowledge)? Specific to:
    a. public sector
    b. for-profit/private sector
    c. non-profit sector
2. What interventions have been implemented to increase AT supply/access?
3. Why did these interventions work/not work to increase AT supply/access?

B. Understanding barriers and facilitators to increasing AT supply and access
1. Please describe the supply-chain of a specific AT product from manufacturer to consumer.
2. What country-level policies and regulations would facilitate increased access?
3. What procurement processes would help reduce cost of imported AT?
4. Why are so few products manufactured locally/regionally?
5. Which product types are most and least feasible to manufacture and repair locally (country-level)/regionally (Southern Africa)? Why?
6. Given that governments (MOH, MOE, MVA) are providers of AT in Southern Africa, what can government entities do to address unmet demand?
    a. Quantity procured
    b. Appropriateness/quality/safety of products selected
    c. Reach (distribution beyond urban hubs)
7. Which other stakeholders other than government are critical in increasing AT supply? Why and how?
    a. For-profit suppliers
    b. International manufacturers
    c. Non-profits
    d. End users

C. Subset - For-profit sector: AT manufacturers and suppliers
    1. What would allow your company to purchase and provide more AT products (e.g., quantity, range of products)?
    2. What regulations or processes could be developed to reduce the purchase price of AT products?
    3. What regulations are needed ensure product quality and safety?

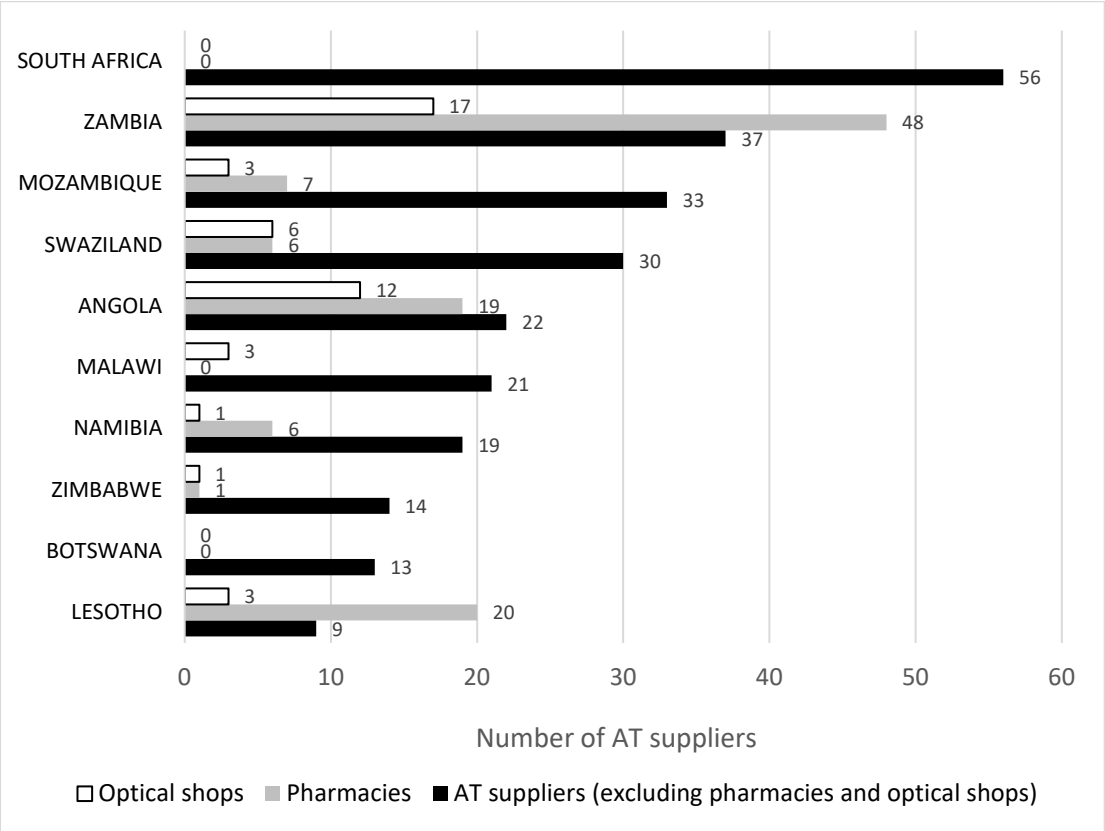
D. Subset - Public AT sector: Representatives from public sector who are involved in AT procurement and provision
    1. Which product types are govt. (your ministry) procuring/not procuring?
    2. How does procurement process for AT work within your ministry/department?
        a. Centralized vs. decentralized purchasing and financing
        b. Determination of quantity/quality/types to purchase (who, how)
        c. Challenges in procurement process
        d. Number of channel intermediaries between manufacturing to consumer
    3. Other than budget constraints, are there other reasons why govt. is not able to purchase more AT (e.g., quantity, range of products)?
    4. What regulations are in place to ensure product quality and safety?
        a. What new/modified regulations are needed?
        b. How are regulations enforced?

APPENDIX D: AT-INFO-MAP INFORMATION

Brief summary of AT-Info-Map Data

The number of AT suppliers identified in each of the 10 Southern African countries provides a very rough estimate as the data collection criteria and approach were not consistent across countries (Chart D.1). Most countries included some optical shops and pharmacies as AT suppliers. In South Africa, the inclusion of optical shops and pharmacies would have resulted in many more hundreds if not thousands of records. Most AT suppliers identified within South Africa specialized in the AT sector (i.e., Mobility Solutions) whereas in many other countries such as Mozambique or Swaziland many AT suppliers had a broader focus than AT (e.g., development organisations that served many needs and also provided wheelchairs, electronics companies that provided a few types of AT alongside mainstream electronic products).

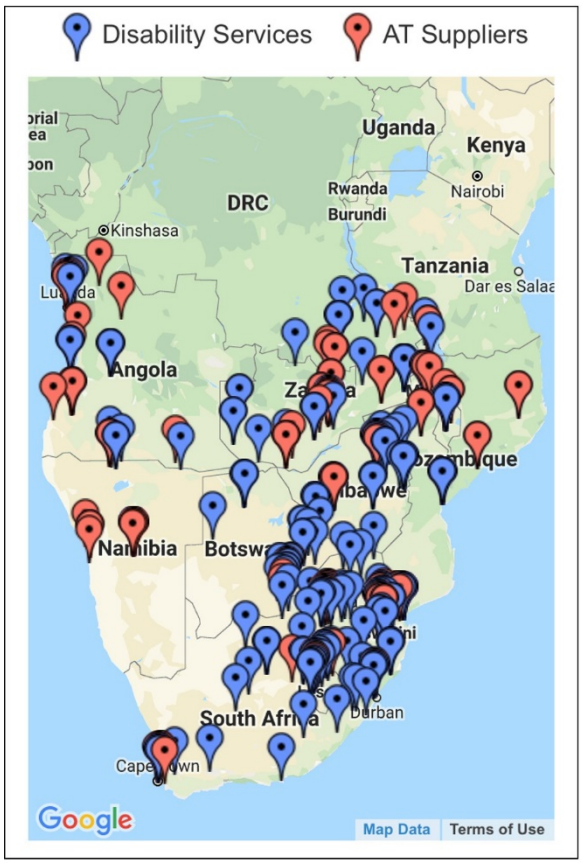
Chart D.1 AT-Info-Map suppliers by country

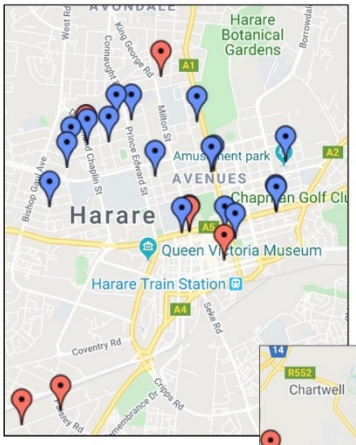


The mapping of AT Suppliers (red flags) and Disability Services (blue flag) shows that many more Disability services providers were identified than AT Supplier in the Southern Africa region (Figure D.2) This figure also displays screenshots when zooming in on Harare (with fewer suppliers) and Johannesburg (with more suppliers).

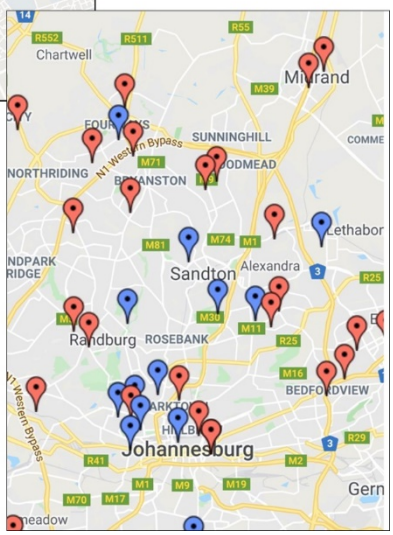
Figure D.1 AT-Info-Map Screenshots of AT Disability Services and Suppliers

AT-Info-Map Regional Screenshot





AT-Info-Map
Harare
Screenshot



AT-Info-Map
Johannesburg
Screenshot

APPENDIX E: FIGURES OF OUTCOMES OF CONTRIBUTING FACTORS

Note that figure numbering is consistent with casual maps presented in the findings in Chapters 5 and 6.

Figure 5.3 AT end user experience: Outcomes and contributing factors

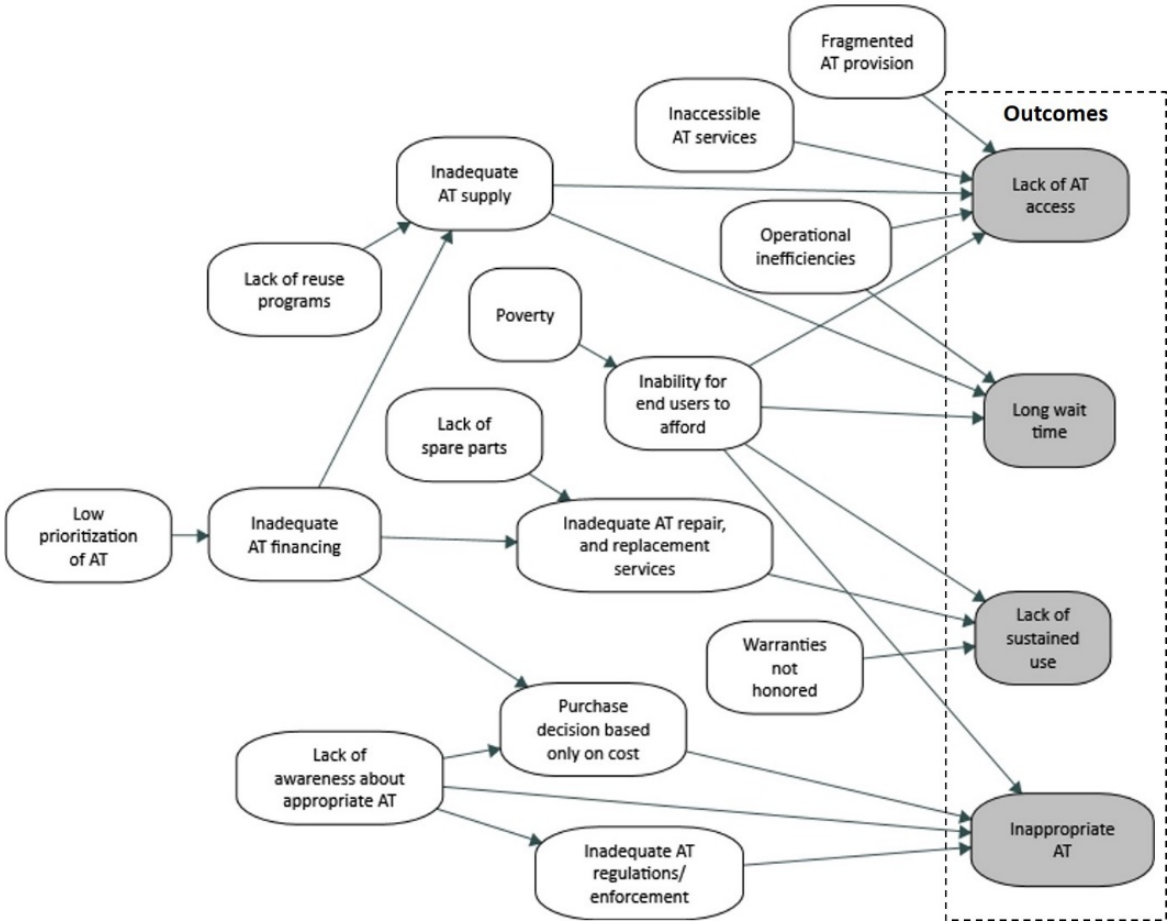


Figure 5.4 Product supply: Outcome and contributing factors

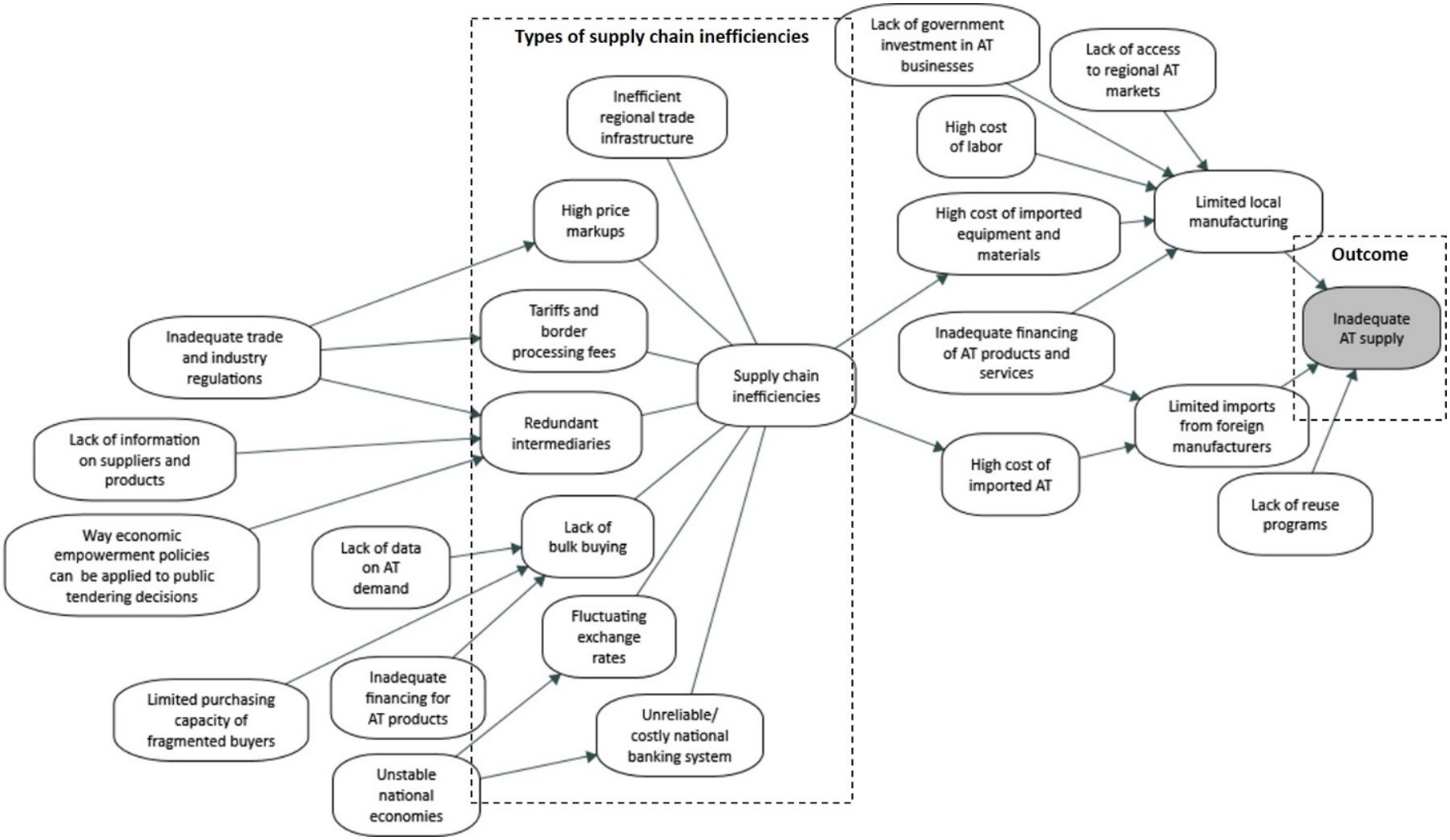


Figure 6.3 Awareness building block: Outcomes and contributing factors

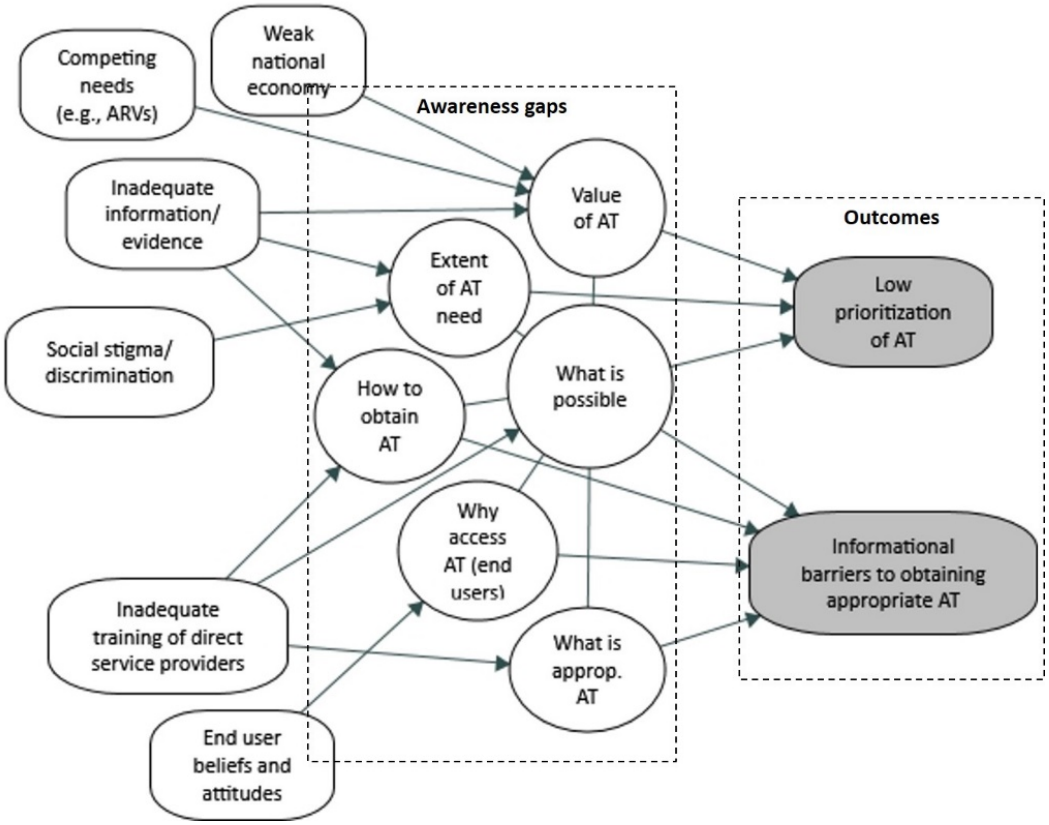


Figure 6.5 Financing building block: Outcomes and contributing factors

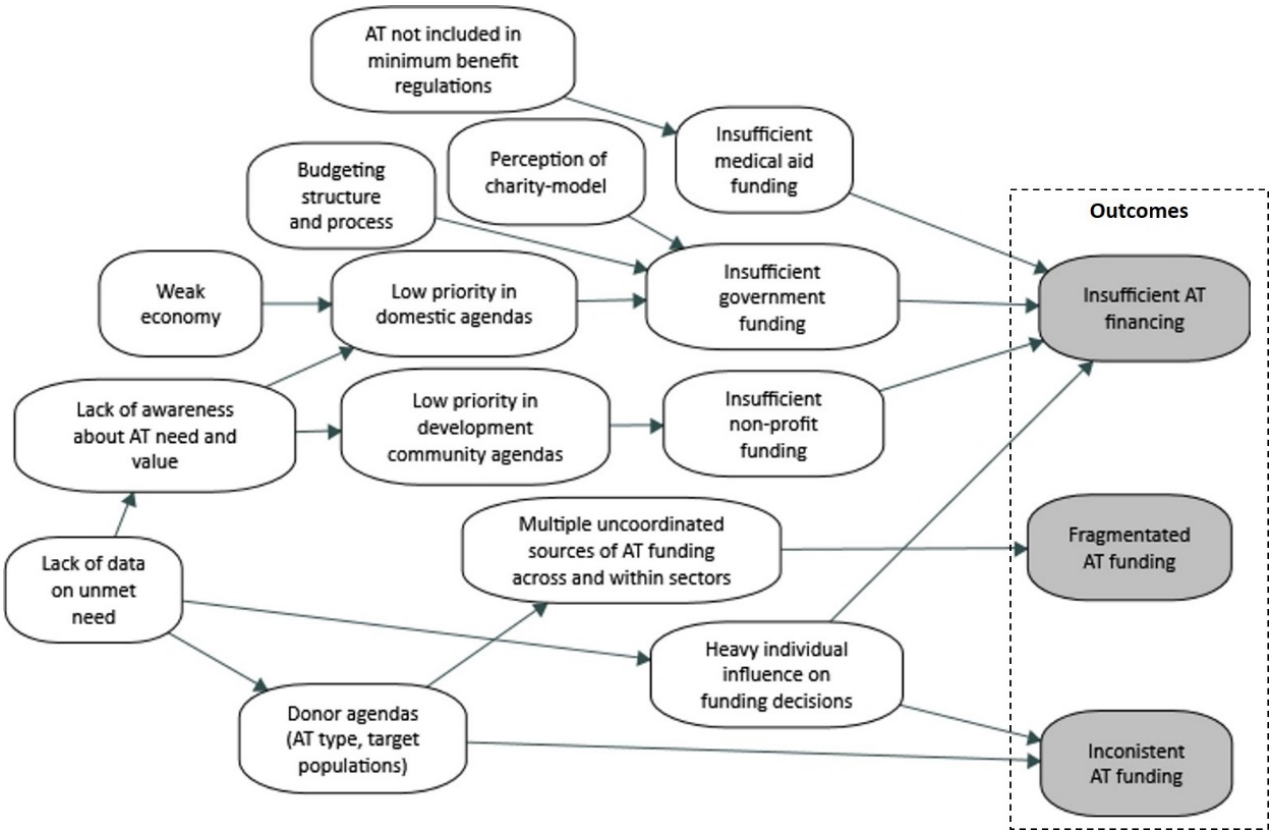


Figure 6.7 Human resources building block: Outcomes and contributing factors

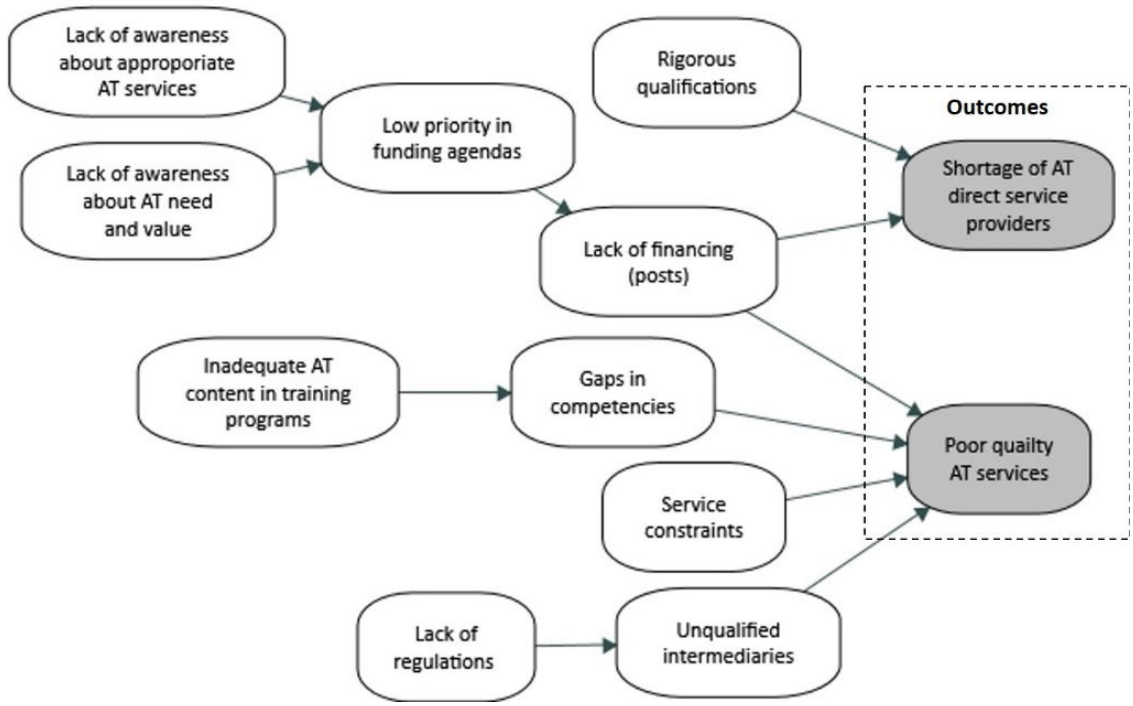


Figure 6.11 Operations building block: Outcomes and contributing factors

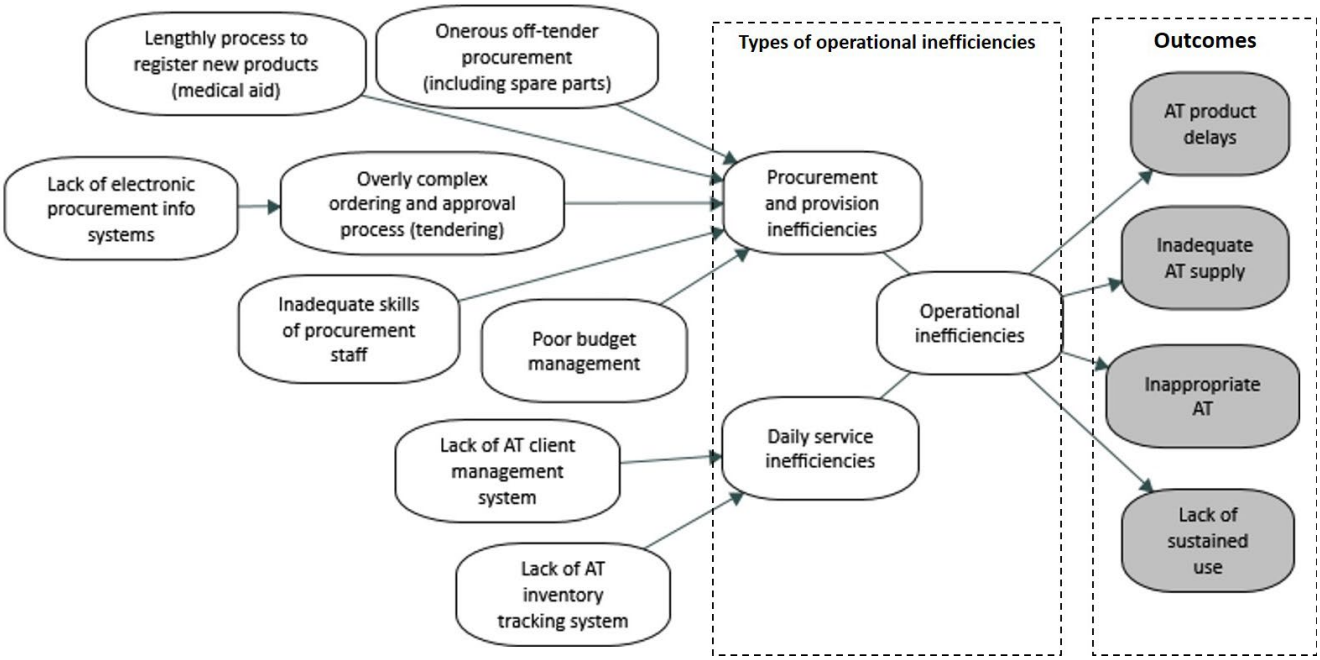
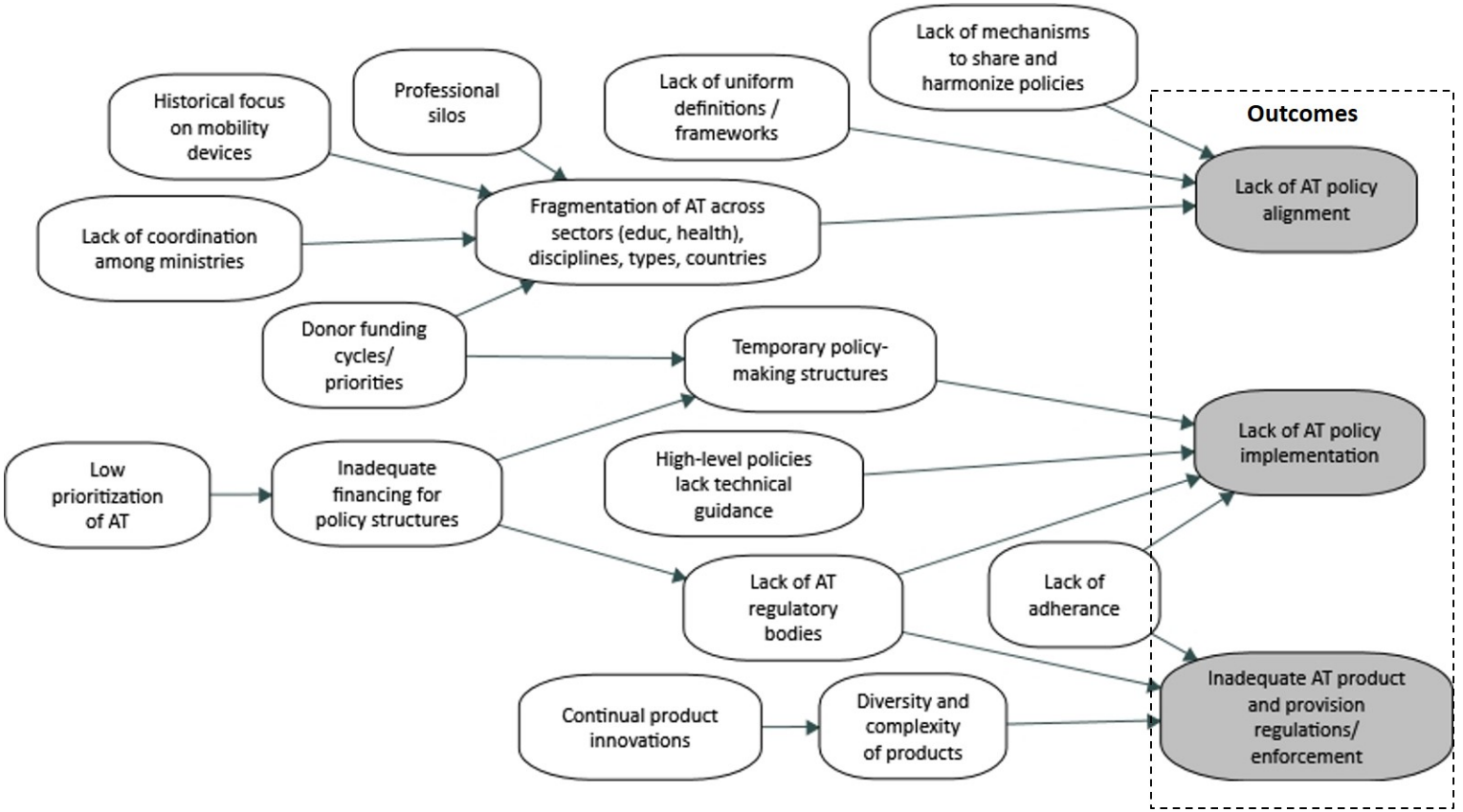


Figure 6.9 Policies building block: Outcomes and contributing factors



APPENDIX F. APPROVAL LETTER FORM DOCTORAL DEGREE BOARD TO INCLUDE PUBLICATIONS IN THESIS

Gmail

Rebecca Matter <matter.rebecca@gmail.com>

Permission to Include Publications in PhD Thesis: Rebecca Ann Matter MTTREB001

2 messages

DOCTORAL DEGREES BOARD <ddb@uct.ac.za> Tue, Dec 3, 2019 at 5:33 AM
To: Becky Matter <MTTREB001@myuct.ac.za>, Rebecca Matter <matter.rebecca@gmail.com>
Cc: Adri Winckler <adri.winckler@uct.ac.za>, Christopher Colvin <CJ.Colvin@uct.ac.za>

Dear Rebecca Matter

I hereby confirm that the Deputy Chair of the Doctoral Degrees Board has **approved** your request to include the specified publications in your PhD thesis.

In your thesis (after your declaration that it is your own work) please include the following separate signed statement listing the publications that you were given permission to include:

"I confirm that I have been granted permission by the University of Cape Town's Doctoral Degrees Board to include the following publication(s) in my PhD thesis, and where co-authorships are involved, my co-authors have agreed that I may include the publication(s): "

This declaration serves to notify examiners that the Doctoral Degrees Board has granted you permission to include publications in your thesis.

Yours sincerely

JANINE ISAACS

Doctoral Degrees Board Officer

UNIVERSITY OF CAPE TOWN

Room 5.04 | Masingene Building | Cross Campus Road |

| Middle Campus | Rondebosch | South Africa | 7700

Doctoral Candidates Webpage

+27 (0) 21 650 2202

Declaration - Inclusion of publications.docx
23K

REFERENCES

Adam, T. (2014). "Advancing the application of systems thinking in health." Health Res Policy Syst **12**: 50.

Adam, T., Hsu, J., de Savigny, D., Lavis, J.N., Rottingen, J.A. and Bennett, S. (2012). "Evaluating health systems strengthening interventions in low-income and middle-income countries: are we asking the right questions?" Health Policy Plan **27 Suppl 4**: iv9-19.

Agyepong, I.A., Sewankambo, N., Binagwaho, A., Coll-Seck, A.M., Corrah, T., Ezeh, A., et al. "The path to longer and healthier lives for all Africans by 2030: the Lancet Commission on the future of health in sub-Saharan Africa." (1474-547X (Electronic)).

Albala, S., Holloway, C., MacLachlan, M., Banes, D. and Bandukda, R. (2019). Capturing and Creating Value in the Assistive Technologies Landscape through a Mission-Oriented Approach: A New Research and Policy Agenda. AT2030 Working Paper Series (1), AT2030. **1**.

Amedofu, G.K., Awuah, P., Ocansey, G., Antwi, B. and Brobby, G.W. (2004). "Utilization of hearing aids by the hearing-impaired in Ghana." Trop Doct **34**(2): 118-120.

Amosun, S., Ndosi, A. and Buchanan, H. (2016). "Locally manufactured wheelchairs in Tanzania - are users satisfied?" Afr Health Sci **16**(4): 1174-1181.

Andrysek, J. (2010). "Lower-limb prosthetic technologies in the developing world: A review of literature from 1994-2010." Prosthet Orthot Int **34**(4): 378-398.

Arksey, H. and O'Malley, L. (2005). "Scoping studies: towards a methodological framework." International Journal of Social Research Methodology **8**(1): 19-32.

ATscale Global Partnership for Assistive Technology (2019). Strategy Overview: ATscale Global Partnership for Assistive Technology.

Austin, V. (2019). Overcoming systematic global barriers to AT: A new metholodology and quick-start testing through a 20m programme. Global Report on Assistive Technology (GReAT) Consultation, Geneva, WHO.

Bigdeli, M., Jacobs, B., Tomson, G., Laing, R., Ghaffar, A., Dujardin, B., et al. (2013). "Access to medicines from a health system perspective." Health Policy Plan **28**(7): 692-704.

Bigdeli, M., Javadi, D., Hoebert, J., Laing, R., Ranson, K. and Medicines, T.A.f.H.P.a.S.R.n.o.r.o.A.t. (2013). "Health policy and systems research in access to medicines: a prioritized agenda for low- and middle-income countries." Health Research Policy and Systems **11**: 37.

Bigdeli, M., Peters, D. and Wagner, A. (2014). Medicines in Health Systems: Advancing access, affordability and appropriate use., Alliance for Health Policy and Systems Research & World Health Organisation.

Boot, F.H., Dinsmore, J., Khasnabis, C. and MacLachlan, M. (2017). "Intellectual Disability and Assistive Technology: Opening the GATE Wider." Front Public Health **5**: 10.

Boot, F.H., Owuor, J., Dinsmore, J. and MacLachlan, M. (2018). "Access to assistive technology for people with intellectual disabilities: a systematic review to identify barriers and facilitators." J Intellect Disabil Res.

Borg, J. (2019). Setting the scene. Global Report on Assistive Technology (GReAT) Consultation, Geneva, WHO.

Borg, J., Lindstrom, A. and Larsson, S. (2011). "Assistive technology in developing countries: a review from the perspective of the Convention on the Rights of Persons with Disabilities." Prosthet Orthot Int **35**(1): 20-29.

Bozzani, F.M., Griffiths, U.K., Blanchet, K. and Schmidt, E. (2014). "Health systems analysis of eye care services in Zambia: evaluating progress towards VISION 2020 goals." BMC health services research **14**: 94.

Braillo (2018). "Braillo 300 S2 Braille Printer." Retrieved November 21, 2018, from http://braillo.com/braillo-300-braille-embosser/.

Bright, T., Mulwafu, W., Thindwa, R., Zuurmond, M. and Polack, S. (2017). "Reasons for low uptake of referrals to ear and hearing services for children in Malawi." PLoS One **12**(12): e0188703.

Bureau of Internet Accessibility (2019). "Assistive technology market estimates: Rapid growth ahead." Accessibility.Blog https://www.boia.org/blog/assistive-technology-market-estimates-rapid-growth-ahead Accessed December 12, 2019.

Cameron, A., Ewen, M., Ross-Degnan, D., Ball, D. and Laing, R. (2009). "Medicine prices, availability, and affordability in 36 developing and middle-income countries: a secondary analysis." Lancet **373**(9659): 240-249.

Chireshe, R. (2013). "The State of Inclusive Education in Zimbabwe: Bachelor of Education (Special Needs Education) Students' Perceptions." Journal of Social Sciences **34**(3): 223-228.

Cochrane, H. (2019). International education standards for prosthetics and orthotic services. Global Report on Assistive Technology (GReAT) Consultation, Geneva, WHO.

Cook, A.M. and Polgar, J.M. (2014). "Assistive technologies : principles and practice."

Council for Medical Schemes (2019a). "Conditions covered, Which conditions are covered?" Retrieved September 9, 2019, from https://www.medicalschemes.com/medical_schemes_pmb/conditions_covered.htm.

Council for Medical Schemes (2019b). "Medical schemes." Retrieved December 12, 2019, from https://www.medicalschemes.com/MedicalSchemes.aspx.

Dada, S., Murphy, Y. and Tonsing, K. (2017). "Augmentative and alternative communication practices: a descriptive study of the perceptions of South African speech-language therapists." Augment Altern Commun **33**(4): 189-200.

Das Nair, R. and Chisoro, S. (2016). The expansion of regional supermarket chains and implications for local suppliers. A Comparison of findings from South Africa, Botswana, Zambia, and Zimbabwe WIDER Working Paper 2016/169. Helsinki, UNU-WIDER.

de Witte, L. (2019). Models of AT service delivery in low resource settings; a literature review of different approaches and their impact. Global Report of Assistive Technology (GReAT) Consultation, Geneva, WHO.

Department of Education, S.A. (2001). Education White Paper 6. Special needs education: Building an inclusive education and training system. Pretoria, Government Printer.

Diaconu, K., Chen, Y.F., Cummins, C., Jimenez Moyao, G., Manaseki-Holland, S. and Lilford, R. (2017). "Methods for medical device and equipment procurement and prioritization within low- and middle-income countries: findings of a systematic literature review." Global Health **13**(1): 59.

Doherty, J.E. (2015). "Regulating the for-profit private health sector: lessons from East and Southern Africa." Health Policy Plan **30 Suppl 1**: i93-102.

Dziva, C., Shoko, M. and Zvobgo, E.F. (2018). "Implementation of the 2006 Convention on the Rights of Persons with Disabilities in Zimbabwe: A review." African Journal of Disability (Online) **7**: 1-7.

EASTIN and AAATE (2012). AAATE Service Delivery Systems for Assistive Technology in Europe: Position Paper.

Eide, A.H. (2014). Studies on Living Conditions Among People With Disability In Low-Income Countries as a Strategy for Monitoring CRPD. UNESCO Meeting on Disability Data and Statistics 8 – 10 July 2014, SINTEF Technology and Society.

Eide, A.H., Jele, B. (2011). Living Conditions among People with Disabilities in Swaziland. A National Representative Study. Oslo.

Eide, A.H., Mmatli, T. (2016). Living Conditions among People with Disabilities in Botswana. Oslo.

Eide, A.H. and Øderud, T. (2009). Assistive technology in low-income countries. Disability & international development: towards inclusive global health. MacLachlan and Swartz. New York, Springer.

Elsaesser, L.-J. and Bauer, S. (2012). "Integrating medical, assistive, and universal design products and technologies: Assistive Technology Service Method (ATSM)." Disability and Rehabilitation: Assistive Technology **7**(4): 282-286.

Ennion, L. and Johannesson, A.J. (2017). "A qualitative study of the challenges of providing pre-prosthetic rehabilitation in rural South Africa." Prosthet Orthot Int: 309364617698520.

Fineberg, A.E. (2019). Establishing a cross-sector partnership to increase access to assistive technology. Global Report on Assistive Technology (GReAT) Consultation, Geneva, WHO.

Fleiss, J.L. (1981). Statistical methods for rates and proportions. New York, John Wiley.

Garcon, L., Khasnabis, C., Walker, L., Nakatani, Y., Lapitan, J., Borg, J., et al. (2016). "Medical and Assistive Health Technology: Meeting the Needs of Aging Populations." Gerontologist **56 Suppl 2**: S293-302.

Gilson, L., Hanson, K., Sheikh, K., Agyepong, I.A., Ssengooba, F. and Bennett, S. (2011). "Building the field of health policy and systems research: social science matters." PLoS Med **8**(8): e1001079.

Global Disability Innovation Hub (2019). "Innovate Now: How is GDI Hub Accelerating Disability Innovation in Kenya?" Retrieved December 10, 2019, from https://www.disabilityinnovation.com/practice/innovate-now-how-is-gdi-hub-accelerating-disability-innovation-in-kenya.

Govender, S.M. and Khan, N.B. (2017). "Knowledge and cultural beliefs of mothers regarding the risk factors of infant hearing loss and awareness of audiology services." Journal of Public Health in Africa **8**(1): 43-48.

Government of the Kingdom of Lesotho (2011). The national disability and rehabilitation policy: Mainstreaming persons with disabilities into society. Ministry of Health And Social Welfare. Maseru.

Government of Zimbabwe (1992). Disabled Persons Act. Parliament of Zimbabwe. Harare.

Grant, M.J. and Booth, A. (2009). "A typology of reviews: an analysis of 14 review types and associated methodologies." Health Info Libr J **26**(2): 91-108.

Gunawardena, N.S., Seneviratne, R.A. and Athauda, T. (2004). "Prosthetic outcome of unilateral lower limb amputee soldiers in two districts of Sri Lanka." Journal of Prosthetics & Orthotics (JPO) **16**(4): 123-129.

Gupta, N., Castillo-Laborde, C. and Landry, M.D. (2011). "Health-related rehabilitation services: assessing the global supply of and need for human resources." BMC Health Serv Res **11**: 276.

Guyatt, G., Oxman, A.D., Akl, E.A., Kunz, R., Vist, G., Brozek, J., et al. (2011). "GRADE guidelines: 1. Introduction-GRADE evidence profiles and summary of findings tables." J Clin Epidemiol **64**(4): 383-394.

Hanass-Hancock, J., Nene, S., Deghaye, N. and Pillay, S. (2017). "'These are not luxuries, it is essential for access to life': Disability related out-of-pocket costs as a driver of economic vulnerability in South Africa." African Journal Of Disability **6**: 280-280.

He, M., Abdou, A., Naidoo, K.S., Sapkota, Y.D., Thulasiraj, R.D., Varma, R., et al. (2012). "Prevalence and correction of near vision impairment at seven sites in China, India, Nepal, Niger, South Africa, and the United States." American Journal of Ophthalmology **154**(1): 107-116.

Health Professionals Council of South Africa (2019). "Health Professionals Council of South Africa, homepage." Retrieved December 24, 2019, from https://www.hpcsa.co.za/.

Higgins, J.P., Altman, D.G., Gotzsche, P.C., Juni, P., Moher, D., Oxman, A.D., et al. (2011). "The Cochrane Collaboration's tool for assessing risk of bias in randomised trials." BMJ **343**: d5928.

Holloway, C. (2019). AT innovation ecosystem design: The AT2030 innovate now ecosystem. Global Report on Assistive Technology (GReAT) Consultation, Geneva, WHO.

Holloway, C., Chiira, B., Oldfrey, B. and al, e. (2019). Assistive technology innovation ecosystem design: A Kenyan case study. Global perspectives on assistive technology: proceedings of the GReAT Consultation 2019, Geneva, WHO.

Ikeda, A.J., Grabowski, A.M., Lindsley, A., Sadeghi-Demneh, E. and Reisinger, K.D. (2013). "A scoping literature review of the provision of orthoses and prostheses in resource-limited environments 2000-2010. Part one: considerations for success." Prosthet Orthot Int.

International Organization for Standardization (2016). ISO 9999:2016: Assistive products for persons with disability – Classification and terminology. Geneva, International Organization for Standardization

International Social Security Association (2016). ISSA Guidelines: Return to Work and Reintegration. Geneva, International Social Security Association

International Social Security Association (2019). "ISSA Liaison Office for Southern Africa." Retrieved December 13. 2019, from https://www.issa.int/en_GB/liaison-south-africa/about.

International Society for Prosthetics and Orthotics (2019). "ISPO Accredited Schools and Training Programmes." Retrieved December 12, 2019, from https://www.ispoint.org/page/Programmes.

Jacobs, B., Ir, P., Bigdeli, M., Annear, P.L. and Van Damme, W. (2012). "Addressing access barriers to health services: an analytical framework for selecting appropriate interventions in low-income Asian countries." Health Policy Plan **27**(4): 288-300.

Johnston, M., Vanderheiden, G., Farkas, M., Rogers, E., Summers, J., Westbrook, J. (2009). The challenge of evidence in disability and rehabilitation research and practice: A position paper. Austin, TX, NCDDR Task Force on Standards of Evidence and Methods.

Kayange, G. and Matter, R. (2017). AT-Info-Map: Increasing Access To Assistive Technology In Southern Africa. 5th AfriNEAD Conference, College of Health and Science at Kwama Nkrumah University of Science and Technology, Kumasi, Ghana.

Khasnabis, C. (2013). Appropriate Assitive Techology [Keynote]. Symposium on Disability, Technology and Rehabilitation in Low and Middle Income Countries, Seattle, WA.

Khasnabis, C., Mirza, Z. and MacLachlan, M. (2015). "Opening the GATE to inclusion for people with disabilities." Lancet **386**(10010): 2229-2230.

Kiwanuka, S.N., Ekirapa, E.K., Peterson, S., Okui, O., Rahman, M.H., Peters, D., et al. (2008). "Access to and utilisation of health services for the poor in Uganda: a systematic review of available evidence." Trans R Soc Trop Med Hyg **102**(11): 1067-1074.

Lankowski, A.J., Siedner, M.J., Bangsberg, D.R. and Tsai, A.C. (2014). "Impact of geographic and transportation-related barriers on HIV outcomes in sub-Saharan Africa: a systematic review." AIDS Behav **18**(7): 1199-1223.

Laviers, H.R., Omar, F., Jecha, H., Kassim, G. and Gilbert, C. (2010). "Presbyopic spectacle coverage, willingness to pay for near correction, and the impact of correcting uncorrected presbyopia in adults in Zanzibar, East Africa." Invest Ophthalmol Vis Sci **51**(2): 1234-1241.

Lewin, S., Glenton, C., Munthe-Kaas, H., Carlsen, B., Colvin, C.J., Gulmezoglu, M., et al. (2015). "Using qualitative evidence in decision making for health and social interventions: an approach to assess confidence in findings from qualitative evidence syntheses (GRADE-CERQual)." PLoS Med **12**(10): e1001895.

Loeb, M.E. (2016). International Census/Survey Data and the Short Set of Disability Questions developed by the Washington Group on Disability Statistics, Springer.

Löfvenmark, I., Hasselberg, M., Nilsson Wikmar, L., Hultling, C. and Norrbrink, C. (2017). "Outcomes after acute traumatic spinal cord injury in Botswana: from admission to discharge." Spinal Cord **55**(2): 208-212.

Lord, J.E., Suozzi, D. and Taylor, A.L. (2010). "Lessons from the experience of U.N. Convention on the Rights of Persons With Disabilities: addressing the democratic deficit in global health governance." The Journal of law, medicine & ethics : a journal of the American Society of Law, Medicine & Ethics **38**: 564-579.

Mackintosh, M., Channon, A., Karan, A., Selvaraj, S., Cavagnero, E. and Zhao, H. (2016). "What is the private sector? Understanding private provision in the health systems of low-income and middle-income countries." Lancet **388**(10044): 596-605.

MacLachlan, M., Banes, D., Bell, D., Borg, J., Donnelly, B., Fembek, M., et al. (2018). "Assistive technology policy: a position paper from the first global research, innovation, and education on assistive technology (GREAT) summit." Disabil Rehabil Assist Technol **13**(5): 454-466.

MacLachlan, M., McVeigh, J., Cooke, M., Ferri, D., Holloway, C., Austin, V., et al. (2018). "Intersections Between Systems Thinking and Market Shaping for Assistive Technology: The SMART (Systems-Market for Assistive and Related Technologies) Thinking Matrix." Int J Environ Res Public Health **15**(12).

MacLachlan, M. and Scherer, M.J. (2018). "Systems thinking for assistive technology: a commentary on the GREAT summit." Disabil Rehabil Assist Technol **13**(5): 492-496.

Magadzire, B.P., Marchal, B. and Ward, K. (2015). "Improving access to medicines through centralised dispensing in the public sector: a case study of the Chronic Dispensing Unit in the Western Cape Province, South Africa." BMC Health Serv Res **15**: 513.

Magnusson, L. and Ahlström, G. (2017). "Patients' Satisfaction with Lower-limb Prosthetic and Orthotic Devices and Service delivery in Sierra Leone and Malawi." BMC Health Services Research **17**(1): 102-102.

Magnusson, L., Ahlstrom, G., Ramstrand, N. and Fransson, E.I. (2013). "Malawian prosthetic and orthotic users' mobility and satisfaction with their lower limb assistive device." Journal of rehabilitation medicine : official journal of the UEMS European Board of Physical and Rehabilitation Medicine **45**(4): 385-391.

Mahmic-Kaknjo, M., Jelicic-Kadic, A., Utrobicic, A., Chan, K., Bero, L. and Marusic, A. (2018). "Essential medicines availability is still suboptimal in many countries: a scoping review." J Clin Epidemiol **98**: 41-52.

Malawi Against Physical Disabilities (2018). "Malawi's only free inpatient rehabilitation facility." http://mapmw.org/malawis-only-free-inpatient-rehabilitation-facility/ Accessed April 15, 2019.

Malawi Government (2006). National Policy on Equalisation of Opportunities for Persons with Disabilities. Ministry of Persons with Disabilities and the Elderly. Lilongwe.

Manig, S.M. (2018). Understanding the rehabilitation needs of persons living with a lower limb amputation in rural areas of the OR Tambo district of the Eastern Cape, South Africa. Masters, Physiotherapy, University of Western Cape.

Mannan, H., Boostrom, C., Maclachlan, M., McAuliffe, E., Khasnabis, C. and Gupta, N. (2012). "A systematic review of the effectiveness of alternative cadres in community based rehabilitation." Hum Resour Health **10**: 20.

Marasinghe, K.M., Lapitan, J.M. and Ross, A. (2015). "Assistive technologies for ageing populations in six low-income and middle-income countries: a systematic review." BMJ Innov **1**(4): 182-195.

Matter, R., Harniss, M., Oderud, T., Borg, J. and Eide, A.H. (2017). "Assistive technology in resource-limited environments: a scoping review." Disabil Rehabil Assist Technol **12**(2): 105-114.

McColl, M.A., Shortt, S., Godwin, M., Smith, K., Rowe, K., O'Brien, P., et al. (2009). "Models for integrating rehabilitation and primary care: a scoping study." Arch Phys Med Rehabil **90**(9): 1523-1531.

McLaren, Z.M., Ardington, C. and Leibbrandt, M. (2014). "Distance decay and persistent health care disparities in South Africa." BMC Health Serv Res **14**: 541.

Mkhize, T. (2018). MVA funds leading the way: Cementing relationships. SADC MVA Funds to pursue objectives of new multilateral agreement, Road Accident Fund.

Modisenyane, S.M., Hendricks, S.J.H. and Fineberg, H. (2017). "Understanding how domestic health policy is integrated into foreign policy in South Africa: a case for accelerating access to antiretroviral medicines." Glob Health Action **10**(1): 1339533.

Mont, D. (2007). Measuring Disability Prevalence. Social Protection Discussion Papers. Disability & Development Prevalence. Washington D.C.

Mukherjee, G. and Samanta, A. (2005). "Wheelchair charity: a useless benevolence in community-based rehabilitation." Disabil Rehabil **27**(10): 591-596.

Murray, C.J., Vos, T., Lozano, R., Naghavi, M., Flaxman, A.D., Michaud, C., et al. (2012). "Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010." Lancet **380**(9859): 2197-2223.

Natasha, R., Casey, C.B., Selma, Š., Shinichi, N., Lori, E., Sawyer, C., et al. (2019). "More than just friends: in-home use and design recommendations for sensing socially assistive robots (SARs) by older adults with depression." Paladyn, Journal of Behavioral Robotics **10**(1): 237-255.

National Department of Health, S.A. (2015). Framework and Strategy for Disability and Rehabilitation Services in South Africa 2015-2020. Health. Pretoria.

National Planning Commission (2000). NPC Level of Living Conditions Survey
Windhoek.

National Student Financial Aid Scheme Guidelines for Applicants with Disabilities for the Department of Higher Education and Training Bursary programme, Disablity Application Information. Higher Education and Training Department. South Africa, Republic of South Africa.

Ned, L., Cloete, L. and Mji, G. (2017). "The experiences and challenges faced by rehabilitation community service therapists within the South African Primary Healthcare health system." Afr J Disabil **6**: 311.

Nkabinde Zandile, P. (2008). Using assistive technology to educate students with developmental disabilities and autism. Autism and Developmental Disabilities: Current Practices and Issues. Anthony, Festus and Sandra, Emerald Group Publishing Limited. **18:** 273-285.

Øderud, T. (2014). "Surviving spinal cord injury in low income countries." African Journal of Disability **3**(2): 9.

Peters, D.H., Garg, A., Bloom, G., Walker, D.G., Brieger, W.R. and Hafizur Rahman, M. (2008). "Poverty and access to health care in developing countries." Annals of the New York Academy of Sciences **1136**: 161-171.

Pillay, V., Chan, V.F., Chinanayi, F.S. and Naidoo, K.S. (2016). "How Do Patients Choose Their Spectacles in the Public Sector of South Africa?" Optometry And Vision Science: Official Publication Of The American Academy Of Optometry **93**(3): 235-242.

Rennie, T., Kibuule, D., Lates, J., Gideon, H., Nangombe, V. and Hunter, C.J. (2019). "Developing a grass-roots method for monitoring medicines shortages in southern Africa: Report of a pilot in Namibia." Res Social Adm Pharm.

Republic of Namibia (2004). National Disability Council Act. Parliament of the Republic of Namibia. Windhoek.

Republic of South Africa (1996). The Consistution of the Republic of South Africa. Minister for Justice and Constitutional Development.

Republic of South Africa (2000). Promotion of Equality and Prevention of Unfair Discrimination Act. Minister of Justice and Constitutional Development.

Republic of South Africa (2004). National Health Act. Parliament of the Republic of South Africa. Cape Town.

Republic of South Africa (2007). Standardisation of Provision of Assistive Devices in South Africa, A Guideline for Use in the Public Sector. Department of Health. Pretoria.

Republic of South Africa (2015a). Framework and Strategy for Disability and Rehabilitation Services in South Africa, 2015 – 2020. Department of Health. Pretoria.

Republic of South Africa (2015b). Policy on reasonable accommodation and assistive devices for employees with disabilities in the public service. Department of Public Service and Administration.

Republic of South Africa (2015c). White Paper on the Rights of Persons with Disabilities. Department of Social Development.

RESNA (2019). "ATP General Info, Assistive Technology Professional (ATP) Certification." Retrieved December 12, 2019, from https://www.resna.org/atp-general-info.

Ribeiro, M.V., Hasten-Reiter Junior, H.N., Ribeiro, E.A., Juca, M.J., Barbosa, F.T. and Sousa-Rodrigues, C.F. (2015). "Association between visual impairment and depression in the elderly: a systematic review." Arq Bras Oftalmol **78**(3): 197-201.

Rios, A., Miguel Cruz, A., Guarin, M.R. and Caycedo Villarraga, P.S. (2014). "What factors are associated with the provision of assistive technologies: the Bogota D.C. case." Disabil Rehabil Assist Technol **9**(5): 432-444.

Ryan, A.B. (2006). Post-Positivist Approaches to Research. Researching and Writing your thesis: a guide for postgraduate students. Antonesa, Fallon, Ryan et al., MACE: Maynooth Adult and Community Education**:** 12-26.

SADC (2012). "Southern African Development Community: About SADC." Retrieved 5 Jan 2018, from http://www.sadc.int/about-sadc/.

Saidi, T. and Douglas, T.S. (2018). "Medical device regulation in South Africa: The Medicines and Related Substances Amendment Act 14 of 2015." S Afr Med J **108**(3): 168-170.

Savage, M. (2019). Applying market shaping approaches to increase access to AT. Global Report on Assistive Technology (GReAT) Consultation, Geneva, WHO.

Savagea, M.T., N & Seghersa, F & Afdhilaa, N & Fineberg, A & Frost, R & Holloway, C & Boiten, S & Allen, M & Kejariwala, R. (2019). "Applying Market Shaping Approaches to Increase Access to Assistive Technology: Summary of the Wheelchair Product Narrative." Global Report on effective access to Assistive Technology, Volume: 2019.

Schneider M, C.M., Kimmie Z, Morgan R, Naicker S, Roberts A, McLaren P, (1999). We also count! The extent of moderate and severe reported disability and the nature of disability experience in South Africa. Pretoria.

Sensory Solutions (2019). Sensory Solutions Online Catalogue. South Africa.

Sexton, S. (2015). "Using the evidence base to improve professional practice in a prosthetic and orthotic service in Malawi, a Low Income Country." Prosthetics and Orthotics International **39**: 432.

Seymour, N. (2019). CBR workers role in wheelchair service provision. Global Report on Assistive Technology (GReAT) Consultation, Geneva, WHO.

Sherr, K., Fernandes, Q., Kante, A.M., Bawah, A., Condo, J. and Mutale, W. "Measuring health systems strength and its impact: experiences from the African Health Initiative." (1472-6963 (Electronic)).

Sherry, K. (2016). Occupations of citizenship: The missing layer in empowered engagement between rural people with disabilities and primary healthcare workers in South Africa. Doctorate of Philosophy, University of Cape Town.

Shore, S. and Juillerat, S. (2012). "The impact of a low cost wheelchair on the quality of life of the disabled in the developing world." Medical Science Monitor **18**(9): CR533-CR542.

Shumba, T.W. and Moodley, I. (2018). "Implementation of disability policy framework in Namibia: A qualitative study." S Afr J Physiother **74**(1): 400.

SINTEF (2013). "Studies on living conditions." Retrieved 22 Dec 2017, from http://www.sintef.no/en/projects/studies-on-living-conditions/.

Smith, E.M., Gowran, R.J., Mannan, H., Donnelly, B., Alvarez, L., Bell, D., et al. (2018). "Enabling appropriate personnel skill-mix for progressive realization of equitable access to assistive technology." Disabil Rehabil Assist Technol **13**(5): 445-453.

Songane, M. (2018). "Challenges for nationwide vaccine delivery in African countries." Int J Health Econ Manag **18**(2): 197-219.

Soomro, N. and Jalal, S. (2013). "Injuries increase the amputee burden at the prosthesis centre: a 2-year retrospective survey of amputees in a low-income setting." Int J Inj Contr Saf Promot **20**(1): 94-98.

South African Bureau of Standards (2019a). "SABS, Accessibility and Disability." Retrieved Decemnber 15. 2019, from https://www.sabs.co.za/Sectors-and-Services/Services/Access/index.asp.

South African Bureau of Standards (2019b). "SABS, Accessibility and Disability - Standards and Publications." Retrieved December 15. 2019, from https://www.sabs.co.za/Sectors-and-Services/Services/Access/access_sp.asp.

South African Health Products Regulatory Authority (2019a). "SAHPRA Homepage." Retrieved Decemeber 15. 2019, from https://www.sahpra.org.za/.

South African Health Products Regulatory Authority (2019b). Who or What is SAHPRA? Pretoria, SAHPRA.

Southern Africa Federation of the Disabled (2017). "Disability Round Table Forum, 20 June - 23 June 2017." Retrieved December 15, 2019, from https://www.safod.net/event-details/nid/68/disability-round-table-forum/.

Southern Africa Federation of the Disabled (2018). AT-Info-Map, Assistive Technology Guide.

Sridhar, D. and Batniji, R. (2008). "Misfinancing global health: a case for transparency in disbursements and decision making." Lancet **372**(9644): 1185-1191.

Sund, T. (2019). Procurement of AT based on Norwegian experiences. Global Report on Assistive Technology (GReAT) Consultation, Geneva, WHO.

Tangcharoensathien, V., Witthayapipopsakul, W., Viriyathorn, S. and Patcharanarumol, W. (2018). "Improving access to assistive technologies: challenges and solutions in low- and middle-income countries." WHO South East Asia J Public Health **7**(2): 84-89.

TATCOT (2019). "About us." Retrieved December 12, 2019, from https://www.tatcot.org/about_us.html.

Team, W.D.a.R. (2014). WHO global disability action plan 2014-2021. Geneva, WHO.

Tebbutt, E., Brodmann, R., Borg, J., MacLachlan, M., Khasnabis, C. and Horvath, R. (2016). "Assistive products and the Sustainable Development Goals (SDGs)." Global Health **12**(1): 79.

The Road Fund (2019). "The Road Fund homepage, Lesotho." Retrieved December 12, 2019, from http://www.roadfund.org.ls/.

Thompson, S., Naidoo, K., Gonzalez-Alvarez, C., Harris, G., Chinanayi, F. and Loughman, J. (2015). "Barriers to use of refractive services in Mozambique." Optom Vis Sci **92**(1): 59-69.

Tigere, B. and Moyo, T. (2019). Actualizing the rights of people living with disabilities (PWDS) in development policies, planning and programming in Africa : a review of selected country experiences. The 4th Annual International Conference on Public Administration and Development Alternatives. Southern Sun Hotel, Tambo International Airport, Johannesburg, South Africa.

Topaloff, L. (2015). "Parent and clinic staff feedback from pilot testing a low-cost brace for clubfoot." Prosthetics and Orthotics International **39**: 573.

UNICEF (2018). The Overview, Assistive Products for Children with Disabilities., UNICEF.

United Nations (2006). "Convention on the Rights of Persons with Disabilities." Retrieved 7 Feb 2018, from https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities.html.

United States Congress (2004). Assistive Technology Act of 2004. Washington DC. Public Law 108-364.

USAID (2016). USAID's Five Focus Areas to Support Persons with Disabilities in the Wheelchair Sector. Washington DC.

van Niekerk, K., Dada, S. and Tonsing, K. (2019). "Influences on selection of assistive technology for young children in South Africa: perspectives from rehabilitation professionals." Disabil Rehabil 41(8): 912-925.

Vergunst, R., Swartz, L., Mji, G., MacLachlan, M. and Mannan, H. (2015). "'You must carry your wheelchair'--barriers to accessing healthcare in a South African rural area." Global Health Action 8: 29003-29003.

Vialle-Valentin, C.E., Serumaga, B., Wagner, A.K. and Ross-Degnan, D. (2015). "Evidence on access to medicines for chronic diseases from household surveys in five low- and middle-income countries." Health Policy Plan 30(8): 1044-1052.

Visagie, S., Eide, A.H., Mannan, H., Schneider, M., Swartz, L., Mji, G., et al. (2017). "A description of assistive technology sources, services and outcomes of use in a number of African settings." Disabil Rehabil Assist Technol 12(7): 705-712.

Visagie, S., Mlambo, T., van der Veen, J., Nhunzvi, C., Tigere, D. and Scheffler, E. (2015). "Is any wheelchair better than no wheelchair? A Zimbabwean perspective." African Journal of Disability 4(1).

Visagie, S., Scheffler, E. and & Schneider, M. (2013). "Policy implementation in wheelchair service delivery in a rural South African setting." African Journal of Disability Vol 2(No 1).

Visagie, S.J., Matter, R., Kayange, G.M., Chiwaula, M., Harniss, M., Mji, G., et al. (2018). "Lessons from the pilot of a mobile application to map assistive technology suppliers in Africa." Afr J Disabil 7: 422.

Wallace, J.F., Hayes, M. and Bailey, M.N. (2000). "Assistive technology loan financing: A status of program impact and consumer satisfaction." Technology and Disability 13(1): 17-22.

WHO. "Medical Device - Full Definition." Retrieved April 5, 2015, from http://www.who.int/medical_devices/full_deffinition/en/.

WHO (2007). Everybody's business: Strengthening health systems to improve health outcomes. WHO's framework for action. Geneva, WHO.

WHO (2008). Guidelines on the provision of manual wheelchairs in less resourced settings. Geneva, WHO.

WHO (2009). Monitoring and evaluation of health systems strengthening: An operational framework. World Bank, Global Alliance on Vaccines Initiative (GAVI) and Global Fund to Fight AIDS Tuberculosis and Malaria (GFATM). Geneva.

WHO (2010). Community-based rehabilitation guidelines. Geneva, WHO.

WHO (2011). Joint position paper on the provision of mobility devices in less-resourced settings: a step towards implementation of the Convention on the Rights of Persons with Disabilities (CRPD) related to personal mobility. Geneva, WHO.

WHO (2012a). "Concept paper: WHO Guidelines on Health-Related Rehabilitation." Retrieved April 5, 2015, from http://who.int/disabilities/care/rehabilitation_guidelines_concept.pdf.

WHO (2012b). WHO Handbook for Guideline Development. Geneva, WHO.

WHO (2013). How to use the ICF: A practical manual for using the International Classification of Functioning, Disability and Health (ICF). Exposure draft for comment. Geneva, WHO.

WHO (2014). Injuries and Violence: The Facts 2014. Geneva, WHO.

WHO (2015). "Global Cooperation on Assistive Health Technology (GATE)." Public health, innovation, intellectual property and trade. Retrieved 7 Feb 2018, from http://www.who.int/phi/implementation/assistive_technology/phi_gate/en/.

WHO (2016a). Disease burden and mortality estimates - YLD estimates, 2000–2016.

WHO (2016b). "Priority Assistive Product List." Public health, innovation, intellectual property and trade. Retrieved 6 Feb 2018, from http://www.who.int/phi/implementation/assistive_technology/global_survey-apl/en/.

WHO (2017a). Global priority research agenda for improving access to high-quality affordable assistive technology. Geneva, WHO.

WHO (2017b). Global strategy and action plan on ageing and health

Geneva, WHO.

WHO (2017c). Health Technolgies (Assistive devices, Medical devices, Laboratory techniques and procedures). WHO Catalogue. WHO. Geneva, WHO.

WHO (2017d). Rehabilitation 2030, A Call to Action. Concept note. Geneva, WHO.

WHO (2017e). "Standards for Prosthetics and Orthotics." Retrieved 23 Oct 2018, from http://www.who.int/phi/implementation/assistive_technology/prosthetics_orthotics/en/.

WHO (2017f). Towards Access 2030: WHO Essential Medicines and Health Products Strategic Framework 2016-2030. Geneva, WHO.

WHO (2018a). "Assistive Technology - Fact Sheet." Retrieved 4 Oct 2018, from http://www.who.int/en/news-room/fact-sheets/detail/assistive-technology.

WHO (2018b). "Resolution WHA71.8. Improving access to assistive technology." Seventy-First World Health Assembly. Retrieved 4 Oct 2018, from http://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_R8-en.pdf.

WHO (2018c). WHO compendium of innovative health technologies for low-resource settings, 2016-2017. Geneva, WHO.

WHO (2019a). Assistive Technology in Tajikistan: Situational Analysis. Copenhagen, WHO Regional Office for Europe.

WHO (2019b). "Disability, Rehabilitation 2030." Retrieved November 11, 2019, from https://www.who.int/disabilities/care/rehab-2030/en/.

WHO (2019c). "Wheelchair Service Training Package - Basic level." Retrieved December 12, 2019, from https://www.who.int/disabilities/technology/wheelchairpackage/en/.

WHO (2019d). WHO Essential Medicines and Health Products Information Portal. Geneva, WHO.

WHO and UNICEF (2015). Assistive Technology for Children with Disabilities: Creating Opportunities for Education, Inclusion and Participation. A discussion paper. Geneva, WHO.

WHO and World Bank (2011). World Report on Disability 2011. Geneva.

WHO Regional Office for Africa (2019). Assistive technology in the African region: results of an online rapid assistive technology capacity survey, WHO Regional Office for Africa.

Wirtz, V.J., Hogerzeil, H.V., Gray, A.L., Bigdeli, M., de Joncheere, C.P., Ewen, M.A., et al. (2017). "Essential medicines for universal health coverage." The Lancet **389**(10067): 403-476.

Woolf, A.D., Erwin, J. and March, L. (2012). "The need to address the burden of musculoskeletal conditions." Best Pract Res Clin Rheumatol **26**(2): 183-224.

World Confederation for Physical Therapy, A.R. (2019). "Physiotherapy Education Programs in Africa." Retrieved December 12, 2019, from https://www.wcptafrica.org/education-practice/physiotherapy-education-programs-in-africa/.

World Federation of Occupational Therapists (2019). "WFOT Approved Education Programmes." Retrieved December 12, 2019, from https://www.wfot.org/programmes/education/wfot-approved-education-programmes.

Wouters, O.J., Sandberg, D.M., Pillay, A. and Kanavos, P.G. (2019). "The impact of pharmaceutical tendering on prices and market concentration in South Africa over a 14-year period." Soc Sci Med **220**: 362-370.

Yadav, P. (2015). "Health Product Supply Chains in Developing Countries: Diagnosis of the Root Causes of Underperformance and an Agenda for Reform." Health Syst Reform **1**(2): 142-154.

Yin, R.K. (2014). Case study research : design and methods, SAGE Publications.